SUGARBEET RESEARCH

2000 REPORT

FOREWORD

SUGARBEET RESEARCH is an annual compilation of progress reports concerning research by U. S. Department of Agriculture, Agricultural Research Service investigators and other cooperators who are engaged in sugarbeet research. The report was assembled and produced at the expense of the Beet Sugar Development Foundation, and is for the sole use of its members and the cooperators. Much of the data has not been sufficiently confirmed to justify general release and interpretations may be modified with additional experimentation. This report is not intended for publication and should not be used for cited reference nor quoted in publicity or advertising. Reproduction of any portion of the material contained herein will not be permitted without the specific consent of the contributor and the Beet Sugar Development Foundation.

The report presents results of investigations strengthened by contributions received under Cooperative Agreement between the USDA Agricultural Service and the Beet Sugar Development Foundation, along with the California Beet Growers Association, the Western Joint Research Committee, the Sugarbeet and Education Board of Minnesota and North Dakota, and Texas A & M University.

Trade names occur in this report solely to provide specific information and do not signify endorsement by the U. S. Department of Agriculture, Texas A & M University, the Beet Sugar Development Foundation or any of the cooperating organizations.

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SUGARBEET RESEARCH

2000 REPORT

Section A

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Cooperation:

Holly Sugar Company
Spreckels Sugar Division
California Beet Growers Association
California Industry Research Committee
Western Sugar Growers Research Committee

This research was supported in part by funds provided through the Beet Sugar Development Foundation (Projects 210, 211, 212, 215, 220, 221, 280, and 281), the California Beet Growers Association, and the California Industry Research Committee.

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VARIETY TRIALS

ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION, 2000

LEWELLEN, R.T. 2001. <u>Population improvement within multigerm, self-fertile, random-mated breeding lines of sugarbeet.</u> J. Sugar Beet Research 38 (in press).

Population improvement in sugarbeet has been a major breeding objective at Salinas. In addition to improvement within conventional self-sterile (S^sS^s), open-pollinated breeding lines, self-fertile (S^f), genetic-male-sterile (aa) facilitated, random-mated populations have been developed. One distinct advantage of these self-fertile populations is that S_o (Aa) plants can be easily self-pollinated to produce sufficient S_1 seed for progeny testing and recurrent selection procedures. These S_1 lines have been evaluated per se and/or testcrossed to evaluate hybrid performance. Selected lines can be both recombined through genetic-male-sterile segregants to produce improved synthetic populations and increased in bulk or by selfing to test as potential parental lines. Disease resistance has been a primary objective. In addition, improvement for sugar yield combining ability has been attempted. From base population 931, subpopulations and synthetics have been developed for several objectives. From these sources, S_1 progenies have been evaluated in replicated field trials. Selected S_1 lines have been recombined and/or individually testcrossed to evaluate hybrid performance. Genetic variability and improvements have been demonstrated for resistance to diseases and bolting and for components of sugar yield. Under relatively nondiseased conditions at Salinas and Brawley in 2000, population 931 had higher sugar yield than most open-pollinated lines and its sugar yield was equal to the mean of four commercial hybrid checks. In other tests, experimental hybrids with population 931 were about 95% of the mean for the commercial hybrids. Sugar yield for testcross hybrids from a set of 32 selected S_1 lines ranged from 87-119% of the mean for four commercial hybrids. The experiences and potential of self-fertile, random-mated populations in sugarbeet breeding will be discussed.

WINTERMANTEL, W.M., J.E. POLSTON, J. ESCUDERO, and E.R. PAOLI. 2001. <u>First report of Tomato Chlorosis Virus in Puerto Rico</u>. Plant Disease 85 (2): 228.

Symptoms of interveinal chlorosis, necrotic flecking, thickening and rolling of leaves were observed on leaves of field-grown tomato (*Lycopersicon esculentum*) plants in Jauna Diaz, Puerto Rico. These symptoms are indicative of those produced by the whitefly-transmitted criniviruses, *Tomato infectious chlorosis virus* (TICV) and *Tomato chlorosis virus* (ToCV) (1). Samples collected from two symptomatic plants were examined by leaf dip, and were found to contain long flexuous rods approximately 800nm in length, characteristic of criniviruses. Symptomatic leaves were used for extraction of total nucleic acid and for whitefly transmission studies. The greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood), is a highly efficient vector of TICV, but an inefficient vector of ToCV, whereas the banded wing whitefly, *T. abutilonea* (Haldeman) is a highly efficient vector of ToCV, but does not transmit TICV (2). Whiteflies of both species were allowed to feed separately on symptomatic tomato leaves for 24 hs, and were subsequently transferred to healthy *Physalis wrightii* and

Nicotiana benthamiana indicator plants. Symptoms characteristic of ToCV infection developed on 3 of 3 *P. wrightii* plants and 2 of 3 *N. benthamiana* plants following transmission by *T. abutilonea*. Only 1 of 3 *P. wrightii*, plants developed such symptoms following transmission by *T. vaporariorum*, while no *N. benthamiana* plants developed symptoms, suggesting that the virus responsible for the tomato disease was ToCV. Dot blot hybridizations were performed with 0.1 g of total nucleic acid extracts from symptomatic leaves of field samples using probes specific for TICV or ToCV (2) as well as probes specific for 4 additional criniviruses. Symptomatic and asymptomatic leaves of plants in transmission tests, as well as comparable leaves from control plants were also tested by dot blot. Although no criniviruses could be detected by dot blot in the original tomato tissue, these hybridizations identified ToCV in all symptomatic plants from the transmission experiments, confirming the presence of ToCV in Puerto Rico. No additional criniviruses were detected in any samples, and negative controls were virus-free. This is the first time a tomato crinivirus has been detected in the Caribbean, outside of the continental United States. The ability of ToCV to be transmitted by 4 different whitefly species increases the potential for this virus to spread throughout the Caribbean basin.

WINTERMANTEL, W.M., J. SEARS, and M. PARRISH. 2000. Synergism and Host Effects in Virus Yellows of Sugarbeet. *Phytopathology* 90: S92.

"Virus yellows" refers to a viral disease complex that results in generalized leaf yellowing of sugarbeet. The complex includes *Beet yellows closterovirus* (BYV) and *Beet western yellows polerovirus* (BWYV) as single or mixed infections, with *Beet mosaic potyvirus* (BtMV) often associated as well. Sugarbeet varieties exhibiting differential levels of tolerance to the yellows complex were inoculated with every combination of one, two or all three viruses. Relative levels of virus were compared among single and mixed infections using dot blot hybridization. Virus titers in sugarbeet were not substantially affected by the presence of multiple viruses, but specific mixed infections severely affected growth of beet plants. Mild increases in stunting severity were found in mixed infections of BYV and BWYV, but these increases were not significant. Mixed infections of BYV with BtMV, however, caused severe stunting in sugarbeet, compared to single infections of either virus or combinations of BYV with BWYV. Synergistic effects on stunting severity were more pronounced in susceptible beet varieties, but similar patterns were also observed in lines exhibiting tolerance to virus yellows. Virus concentration was also affected by mixed infections. Levels of BYV and BtMV were most affected by the presence of an additional virus, as compared to virus levels in single infections.

WISLER, G.C., R.T. LEWELLEN, H.-Y. LIU, J. SEARS, and W.M. WINTERMANTEL. 2001. Interactions between BNYVV and BSBMV in rhizomania resistant and susceptible sugarbeet varieties and effects on beet development. J. Sugar Beet Research 38 (in press).

Beet necrotic yellow vein virus (BNYVV), the cause of Rhizomania, produces striking root and sometimes foliar symptoms, and results in considerable sugar content and yield reductions. This virus was introduced from Europe and has since spread throughout many beet growing regions in the U.S. In contrast, *Beet soil-borne mosaic virus* (BSBMV) appears to have originated and evolved in the U.S. Although this virus does not produce the severe losses that result with BNYVV infection, it does appear to have some effect on yield. Recent studies have

demonstrated that although these viruses are closely related, Rz gene-resistance to BNYVV does not confer resistance to BSBMV. Both viruses are transmitted by *Polymyxa betae* and are being found together in increasing numbers of beet fields in the western United States. As a result, we are not only attempting to ascertain the existence of resistance to BSBMV, but also to determine whether the presence of both viruses together substantially affects beet yield, sugar content and virus concentration. To determine the effect of single and mixed infections of BNYVV, BSBMV, as well as virus-free *P. betae* on susceptible and rhizomania resistant sugarbeet, sterile soils were inoculated with viruliferous beet roots containing *P. betae*, or *P. betae* and one or both viruses. These soils were used in greenhouse tests to explore the effects of mixed infection. Results demonstrated that concentrations of both viruses increased for 3-4 weeks in all combinations, then virus levels begin to decline. In addition, BSBMV levels were suppressed in mixed infections with BNYVV, and BNYVV levels appear to increase substantially in the presence of BSBMV, suggesting a possible synergism between these viruses.

WISLER, G.C. and J.E. DUFFUS. 2000. A century of plant virus management in the Salinas Valley of California, "East of Eden." *Virus Res.* 71: 161-169.

The mild climate of the Salinas Valley, California lends itself well to a diverse agricultural industry. However, the diversity of weeds, crops and insect and fungal vectors also provide favourable conditions for plant virus disease development. This paper considers the incidence and management of several plant viruses that have caused serious epidemics and been significant in the agricultural development of the Salinas Valley during the 20th century. *Beet curly top virus* (BCTV) almost destroyed the newly established sugar beet industry soon after its establishment in the 1870s. A combination of resistant varieties, cultural management of beet crops to provide early plant emergence and development, and a highly coordinated beet leafhopper vector scouting and spray programme have achieved adequate control of BCTV. These programmes were first developed by the USDA and still operate. *Lettuce mosaic virus* was first recognized as causing a serious disease of lettuce crops in the 1930s. The virus is still a threat but it is controlled by a lettuce-free period in December and a seed certification programme that allows only seed lots with less than one infected seed in 30,000 to be grown. “Virus Yellows” is a term used to describe a complex of yellows-inducing viruses which affect mainly sugar beet and lettuce. These viruses include *Beet yellows virus* and *Beet western yellows virus*. During the 1950s the complex caused significant yield losses to susceptible crops in the Salinas Valley. A beet-free period was introduced and is still used for control. The fungus-borne rhizomania disease of sugar beet caused by *Beet necrotic yellow vein virus* was first detected in Salinas Valley in 1983. Assumed to have been introduced from Europe, this virus has now become widespread in California wherever beets are grown and crop losses can be as high as 100%. Movement of infested soil and beets accounts for its spread throughout the beet-growing regions of the United States. Control of rhizomania involves several cultural practices, but the use of resistant varieties is the most effective and is necessary where soils are infested. Rhizomania-resistant varieties are now available that perform almost as well as non-resistant varieties under non-rhizomania conditions. Another soil-borne disease termed lettuce dieback, caused by a tomato bushy stunt-like tombusvirus, has become economically limiting to romaine and leaf lettuce varieties. The virus has no known vector and it seems to be moved through

infested soil and water. Heavy rains in the past four years have caused flooding of the Salinas River and lettuce fields along the river have been severely affected by dieback. Studies are now in progress to characterize this new virus and identify sources of resistance. Agriculture in the Salinas Valley continues to grow and diversify, driven by demands for 'clean', high quality food by the American public and for export. The major aspects of plant virus control, including crop-free periods, breeding for resistance, elimination of inoculum sources, and vector control will continue to be vital to this expansion. Undoubtedly, the advances in crop production through genetic manipulation and advances in pest management through biological control will eventually become an important part of agricultural improvement.

Project 220

Resistance to Beet Yellows Virus through Genetic Enhancement

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Research Sponsors:
Beet Sugar Development Foundation
California Beet Growers Association and California Industry Research Committee

Introduction: Virus yellows consists of a complex of viruses causing beet leaves to turn yellow prematurely, and has contributed to disease-related losses in California sugarbeet production for many years. This disease complex is composed of members of two main genera of plant viruses, a *Closterovirus* and a *Polerovirus*. Once plants begin showing initial yellowing symptoms, losses accumulate approximately 2 percent each week through the remainder of the growing season. Direct annual losses to virus yellows have averaged in excess of $36 million, without considering indirect effects such as the displacement of production areas, increased freight costs, and potential loss of processing facilities due to disease-related yield and revenue reductions.

Plant virus resistance obtained through transformation with foreign genes (transgene-mediated resistance) can increase the level of resistance in cultivars which partially control a particular disease, and can provide resistance when none is available through traditional breeding. This project examines the potential for transgene-mediated resistance against *Beet yellows virus* (BYV). BYV is a major component of the virus yellows complex, and has been identified by the California sugarbeet industry as a primary concern. Engineered BYV resistance should complement current resistance/tolerance to *Beet western yellows luteovirus* (BWYV), the other major viral partner in the virus yellows complex. Transgene-mediated resistance has been studied extensively for a number of years. Since its development in the mid 1980s, transgene-mediated resistance has been developed for control of a large number of plant viruses in many different hosts (Baulcombe, 1996; Deom, 1999), including limited attempts to control BNYVV in sugarbeet (Kallerhoff et al., 1990; Ehlers et al., 1991). There are several means by which foreign genes can engender resistance, and often more than one approach can achieve resistance against a particular virus. For example, transgenic resistance has been achieved for tobacco mosaic virus using viral replicase transgenes as well as by using viral coat protein transgenes. The means by which the replicase transgene produces resistance differs from the mechanism by which coat protein-mediated resistance operates, at least for tobacco mosaic virus. The choice of a transgene (the foreign gene being inserted into the plant genome) must be determined through careful analysis of the type of interaction between the targeted virus and its plant host. The transgene must be able to block the virus infection cycle such that the virus cannot bypass the mechanism of the resistance. It is important, therefore, to have a solid understanding of the nature of the infection process and how disease develops for each virus targeted for transgene-mediated resistance. BYV is transmitted by aphids in a semipersistent manner (requiring long feeding times for acquisition and transmission by vectors). In infected plants, BYV is usually restricted to phloem tissues (sieve tubes, companion cells and phloem parenchyma), but is

occasionally found in the mesophyll and epidermis near local lesions. This suggests that strategies which interfere with virus replication and packaging should be effective in generating resistance to BYV.

Methods: Specific BYV genes were isolated, modified, and inserted into binary plant transformation vectors. An essentially nonproprietary binary vector, provided by W.R. Belknap (USDA-ARS, Albany, CA) and modified in our laboratory, was used to reduce end-product licensing requirements. Plant transformations were performed using *Agrobacterium tumefaciens*-mediated plant transformation with *A. tumefaciens* strain LBA4404, available in the laboratory. Initial tranformations were performed on *N. benthamiana*, an alternate host for BYV. *N. benthamiana* can be transformed easily using standard procedures, and transgenic plants can be tested for resistance to BYV in a fraction of the time required to obtain transgenic sugarbeet. Transgenic *N. benthamiana* plants were tested for the presence of the transgene by PCR analysis. First generation progeny of transformants and non-transformed controls were tested for resistance by inoculation with BYV (transmitted by viruliferous aphids). Plants exhibiting strong resistance will be subjected to Southern blot analysis to determine the number of copies of the transgene in these plants.

Results and Discussion: Transgene constructs consisting of viral replicase and coat protein genes were produced and used to transform both sugarbeet and *Nicotiana benthamiana*. *N. benthamiana* is used as a model host, due to its ability to be transformed and regenerated relatively quickly and efficiently, unlike sugarbeet. The first set of transformants suggested that one of 18 lines may exhibit complete resistance, while several other lines exhibited delayed infection. These results are very preliminary and further testing is in progress. Sugarbeet has also been transformed with these constructs, but this process is difficult, inefficient and time consuming, with the technology available in our laboratory. Due to the advances being made in corporate transgenic research, and our need to concentrate on other critical areas of sugarbeet research, we plan to direct efforts in biotechnology toward development of constructs that can be tested in model hosts. Once identified, these constructs will be licensed to others interested in using them to transform sugarbeet.

Project 221 (Part I)

Characterization of interactions in the virus yellows complex of sugarbeet

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Research Sponsors:
California Beet Growers Association and California Industry Research Committee
The Western Sugar Company-Grower Joint Research Committee

Introduction:

Virus yellows is caused by a complex of viruses causing beet leaves to yellow prematurely, and has contributed to disease-related losses in California sugarbeet production for many years. The virus yellows disease complex is composed of members of two main genera of plant viruses, a *Closterovirus* and a *Polerovirus*. In California, *Beet yellows closterovirus* (BYV) and *Beet western yellows polerovirus* (BWYV) are the principle members. Often, *Beet mosaic potyvirus* (BtMV) is present, as well, although generally this virus does not contribute to significant disease alone. All three viruses are transmitted by aphids. The relationship in sugarbeet between these three viruses was not clear prior to our studies. Although all 3 viruses (BYV, BWYV, and BtMV) can be present in plants at the same time, it was not clear whether the yellowing symptoms and stunting associated with the disease are more severe when multiple viruses are present or not. Furthermore, it was not known whether the presence of one virus facilitates or hinders the activity of another. Possible interactions were suggested by observations that yellowing disease and sugar yield reductions were more severe when both BYV and BWYV are present. It is also noteworthy that BtMV has not been considered a severe problem in beet, even though it is often present in fields with BYV and BWYV.

Traditionally, breeding for resistance to virus yellows has involved breeding for control of the yellowing symptom, caused by BYV and/or BWYV. BtMV causes symptoms on young plants, but as symptoms of the yellowing viruses develop, mosaic symptoms decrease. Currently, sugarbeet breeding lines are available which exhibit tolerance to BYV, and resistance to BWYV. Commercial varieties have not been selected for resistance to BtMV, but resistance sources are known. There is a need for stronger resistance to BYV, as well as a better understanding of the relationships between the viruses involved in the disease complex.

Methods:

Four sugarbeet breeding lines were selected, based on field inoculations, which were either susceptible or exhibited resistance to the target viruses (Table 1). These lines were challenged by aphid-inoculation of BYV, BWYV, and/or BtMV, individually, and with all combinations of

two viruses. Finally, all 3 viruses were inoculated together. Mock inoculations were also performed with virus-free aphids (Table 2).

Table 1. Susceptibility and tolerance of beet breeding lines to BYV, BWYV and BtMV.

Line	BYV	BWYV	BtMV
C37	T	T	S
C76-39-5	T	T	S
US75	S	S	S
SP22-0	VS	VS	S

Abbreviations: BYV, *Beet yellows closterovirus*; BWYV, *Beet western yellows polerovirus*; BtMV, *Beet mosaic potyvirus*, T, Tolerance; S, Susceptible; VS, Very susceptible.

Table 2. Virus combinations inoculated to sugarbeet plants by viruliferous *Myzus persicae*.

Single	Double	Triple
BYV	BYV + BWYV	BYV + BWYV + BtMV
BWYV	BYV + BtMV	
BtMV	BWYV + BtMV	

Mock inoculations were performed with nonviruliferous *M. persicae*. Abbreviations: BYV, *Beet yellows closterovirus*; BWYV, *Beet western yellows polerovirus*; BtMV, *Beet mosaic potyvirus*. Symptom development was examined over the course of each experiment, and total nucleic acid samples were prepared from symptomatic leaves at 8 weeks post-inoculation (wpi) using standard laboratory procedures. Replicate dot blots (a form of nucleic acid hybridization) were performed to compare relative levels of each virus in single, double, and triple infections, using equivalent nucleic acid probes specific for detection of each virus. Relative amounts of viral RNA were compared by phosphorimage analysis of dot blots. Plant ribosomal RNA levels were used as an internal standard to equilibrate total nucleic acid levels among samples.

At the conclusion of each experiment (8 wpi), soil was removed from roots, and total plant weight was determined. Tops and roots were separated to determine the effects of each virus combination on root and top weight, compared with healthy controls.

Results:

Sugarbeet growth is stunted more severely by specific mixed infections than by single infections

The studies described above demonstrated that the stunting associated with virus yellows is more severe when multiple viruses are present (Figure 1). Combinations involving BYV and BtMV are particularly severe, while other combinations (BYV and BWYV or BWYV and BtMV) exhibit only slightly increased stunting compared to inoculations with any of the three viruses alone. These patterns are maintained, but stunting is less severe in beet varieties exhibiting tolerance or resistance to virus yellows (Figure 1c,d). Statistically significant differences in root and total plant weight were most common in susceptible varieties inoculated with different virus combinations (Table 3), but significant differences were also observed in resistant varieties. This study has been replicated 4 times, with high levels of uniformity. An interesting phenomenon was that at 8 wpi when plants were harvested, single infections of BWYV resulted in heavier root and total weight than mock-inoculated plants in all varieties (Figure 1). This effect most certainly would not exist by the end of a normal growing season, and it is not clear what effect BWYV infection might have on stimulating beet growth early in the season.

Greenhouse results comparing symptom severity resulting from both single and mixed infections reflect field data obtained by Robert Lewellen on levels of resistance to virus yellows (BYV and BWYV) among the lines examined. Line SP22-0 was highly susceptible to all 3 viruses, as expected. Synergism was most apparent in this line, and only slightly less apparent in susceptible line US75. Although resistant varieties C37 and C76-89-5 were not affected as severely by virus synergism, these lines continued to exhibit substantial stunting and yellowing, particularly when more than one virus was present. The combination of BYV and BtMV, in particular, resulted in severely stunted beets in all 4 varieties tested.

Figure 1. Effect of mixed infection on sugarbeet root and total weight.

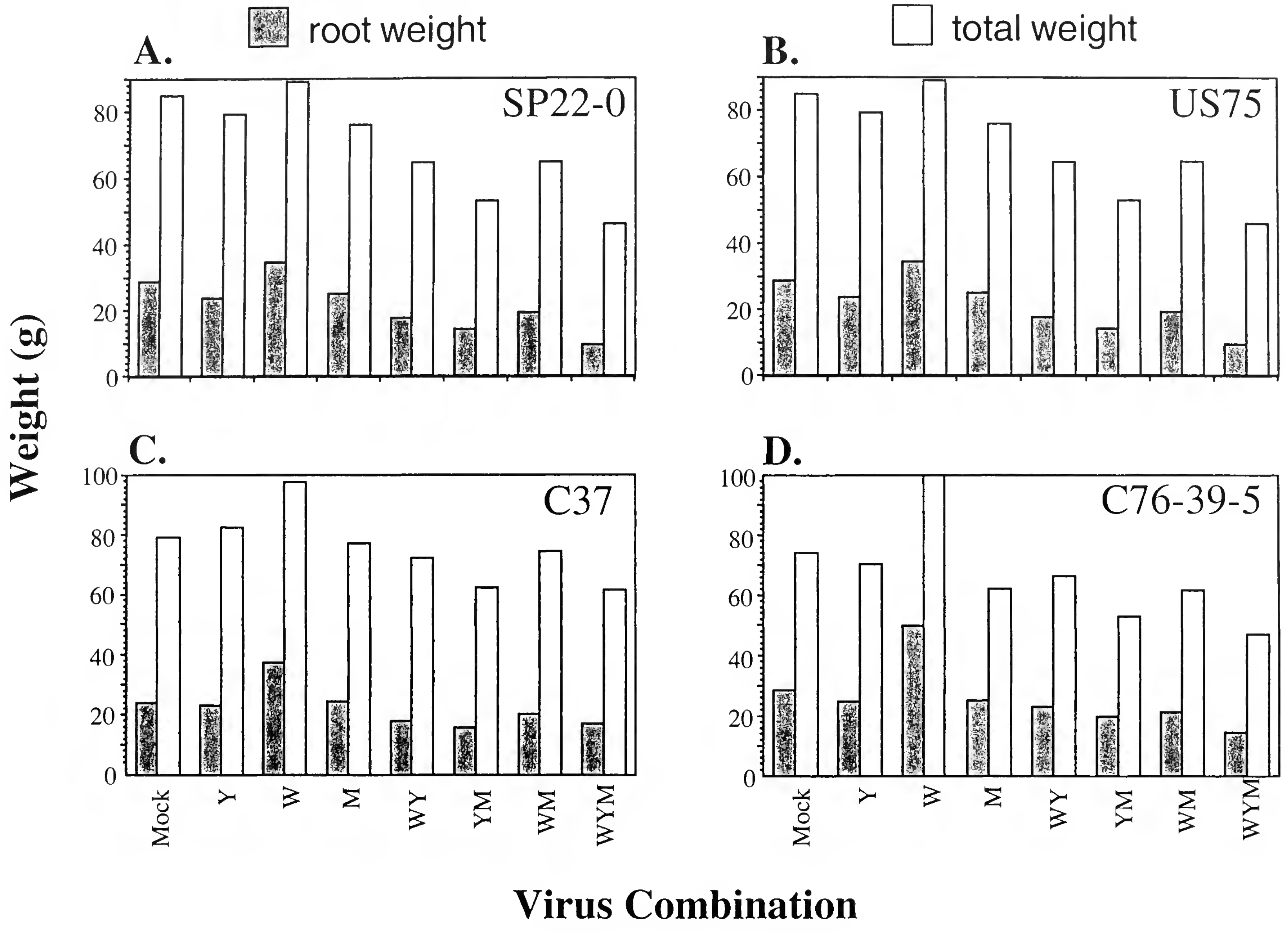


Table 3. Comparison of root and total weight of sugarbeet plants inoculated with different combinations of aphid-transmitted yellowing viruses (8 wpi [1]).

	Sugarbeet Variety							
	SP22-0 (S) [2]		US75 (S)		C76-39-5 (R)		C37 (R)	
Virus Combination	Root	Total	Root	Total	Root	Total	Root	Total
Mock	a [3]	b	a	ab	abcd	abcde	abcd	abc
W	e	a	a	a	abc	abc	ab	ab
Y	b	b	ab	ab	abcd	abc	bcde	bcd
M	a	ab	a	a	abcd	abcde	abc	abc
WY	c	c	bc	cd	bcdef	bcde	ef	cde
WM	b	c	b	b	abcde	abcd	bcde	bcd
YM	cd	d	c	de	cdef	cdef	ef	de
WYM	d	e	c	e	def	ef	cdef	de

1. wpi = weeks post-inoculation
2. S = susceptible variety; R = resistant variety
3. Within columns, virus combinations with the same letter were not significantly different from one another (.05).

Virus levels in sugarbeet are also affected by mixed infections

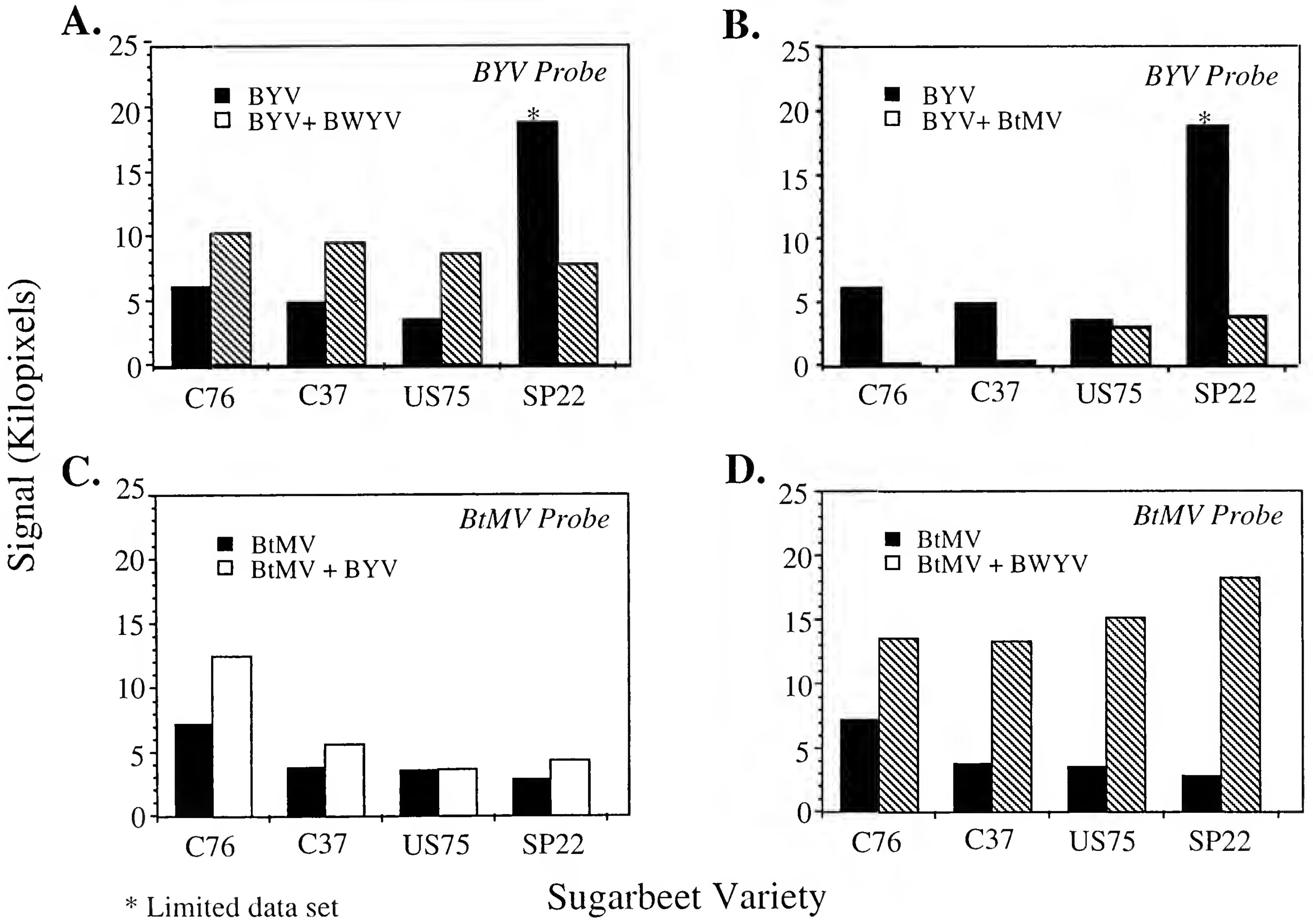
Probes were developed that specifically detect BYV, the *Poleroviruses* BWYV *and Beet chlorosis virus*, and the *Potyvirus*, BtMV. The effect of single and mixed infections on virus concentration in plants demonstrated that levels of BYV approximately double in the presence of BWYV compared with single infections, regardless of the resistance or susceptibility of the beet variety (Figure 2a). In contrast, BYV levels appear to be slightly suppressed in the presence of BtMV (Figure 2b) compared with single infection of BYV. This effect was most pronounced in varieties with tolerance to BYV. Interestingly, levels of BtMV increased in the presence of BYV (Figure 2c) compared with single infection of BtMV. This supported the synergism suggested by the increased stunting observed with this combination of viruses. Most dramatic of all virus interactions was the increase in the level of BtMV in the presence of BWYV, which occurred in all varieties (Figure 2d). Attempts to identify altered levels of BWYV in mixed infections were inconclusive (data not shown).

Discussion:

Three main combinations of viruses caused increased stunting in sugarbeet compared with single infections. The most severe stunting involved combinations of BYV with BtMV, resulting in small plants with poor growth habit. Lesser stunting was observed with BYV and BWYV, as well as with BWYV and BtMV. The combination of BWYV with BYV is not surprising. This combination is not uncommon in fields of central California, and the resulting increased severity appears to be an additive effect. A similar additive effect occurred with BWYV and BtMV. Interestingly, there is little concern in the industry for BtMV, even though the virus is worldwide in distribution and occurs periodically in beet growing regions. In our greenhouse studies, BtMV caused serious problems through synergism with other viruses, particularly BYV. Ironically, both BYV and BtMV are common in California's northern growing region, although not always at the same place or time. Our results suggest that if BtMV infects early it can cause serious problems, when BYV infection occurs at approximately the same time. Field data is not available to determine how frequent such mixed infections are in nature. Both viruses are transmitted by the green peach aphid (*Myzus persicae*), although BYV is also transmitted by the black bean aphid (*Aphis fabae*). *Aphis fabae* populations accumulate rapidly and caused severe virus yellows problems for the northern California beet industry in the mid 1990s.

Of major importance is the availability of sugarbeet varieties with tolerance to BYV. The varieties in this study, C37 and C76-39-5 both performed well under heavy disease pressure, including mixed infections. Severe stunting was common during mixed virus infections in both SP22-0 and US75, which are very susceptible and susceptible, respectively, with regard to yellowing viruses in general. Stunning differences were observed between these varieties and the tolerant varieties with regard to statistically significant differences in stunting severity between single and mixed infections
(Table 3). Essentially, tolerance to yellowing viruses negates most of the synergism occurring between BYV and BtMV, as well as other virus combinations (Figure 1).

Figure 2. Comparison of virus levels in single and mixed infections



Levels of virus were also affected by mixed infection. Results were not statistically significant, but show important trends. Most importantly, BYV levels essentially double in the presence of BWYV. This is consistent with the mild increase in stunting severity observed with this combination of viruses (Figures 1 and 2). No clear pattern was observed with levels of BWYV from the same mixed infections. Some lines were slightly higher, others lower (data not shown). In contrast, levels of BYV were suppressed in the presence of BtMV (Figure 2B), while levels of BtMV were elevated with this combination (Figure 2C). This is likely an effect of the timing of inoculation as well as differential rates of virus accumulation. BtMV accumulates more rapidly in host cells than either BWYV or BYV. While the combination of BYV and BtMV results in severe stunting of plants, the viruses appear to compete with each other in the beet plant. Although BYV is largely confined to the vascular system of the plant, and BtMV primarily affects foliar tissue, the combination (affecting both parts of the plant) is devastating to beet growth and development. At first, it seems unusual that two fundamentally different viruses could affect one another that substantially, however it is possible that BtMV accumulates rapidly and encumbers host cell processes necessary for BYV infection. This could explain the lower levels of BYV in the mixed infections. Importantly, the decrease in BYV levels is even more severe in BYV tolerant varieties. It is possible that accumulation in tolerant varieties is suppressed both by a combination of competition from BtMV as well as through limited host plant suppression of virus accumulation or movement throughout the beet plant. Levels of virus do not appear to be suppressed significantly in single infections of tolerant varieties, however (Figure 2), and this study did not address the possibility of host plant interference with virus movement. BtMV levels were also elevated in the presence of BWYV. Although no clear pattern emerged with BWYV levels, it is possible that overall, BtMV also out competes BWYV for host cell processes, just as it out competes BYV.

Synergism clearly plays a substantial role in virus yellows infections of sugarbeet, affecting both virus accumulation and beet growth and development. The effects observed in this study, while performed under controlled conditions, were designed to examine potential interactions that can and do occur in nature. In most natural virus yellows outbreaks, the disease is caused by one or occasionally two viruses (based on diagnosis of samples sent to our lab for analysis). Severity depends on the viruses involved, and possibly the timing of infection. Tolerant varieties, while not eliminating virus accumulation, are highly successful in reducing the effect of both single and mixed infections on plants. This project was initiated to understand the relationships between the viruses associated with virus yellows, in order to design effective strategies for genetically modifying beets with genes providing complete resistance to virus yellows. Ultimately the knowledge gained in these studies about this disease of sugarbeet, goes far beyond implications for genetic engineering. It allows us to understand some of the variability in the virus yellows complex, and to begin to recognize the complex processes of both the beet plant and the individual viruses that can be affected by this disease.

Project 221 (part II)

Continued study of the new polerovirus causing yellowing in the United States

Hsing-Yeh Liu, G.C. Wisler, and W.M. Wintermantel

Research Sponsors:
Beet Sugar Development Foundation
California Beet Growers Association and California Industry Research Committee
The Western Sugar Company-Grower Joint Research Committee

Introduction:
The term "Virus Yellows" of sugar beets has traditionally been used to describe a complex of aphid-transmitted viruses including *Beet yellows closterovirus* (BYV), and *Beet western yellows* (BWYV) and *Beet mild yellows* (BMYV) *poleroviruses*. Although BWYV is widespread in the United States, BMYV is not known to occur here but is common in Great Britain and Europe. The *poleroviruses* (formerly called "*luteoviruses*") infecting sugar beets and other crops actually consist of a number of viruses which are related to one another in a variety of ways. Host range, relationships based on serology of the capsid protein and on nucleic acid similarities have been studied extensively. These viruses have been partially controlled in the past by elimination of alternate weed hosts, eliminating "ground-keepers", application of systemic insecticides, and by planting resistant varieties.

During the 1995-96 growing season, severely yellowed sugarbeet fields were observed in Colorado and Nebraska. This disease was brought to the attention of researchers at the USDA-ARS in Salinas, CA, Fort Collins, CO, and the University of Nebraska. Although symptoms very closely resembled those caused by BWYV including interveinal yellowing and necrotic lesions caused by Alternaria sp., host range assays and ELISA tests did not identify BWYV as the causal organism. Instead, another virus which has a diagnostic host range distinct from BWYV was detected. This virus appeared to be similar to a new polerovirus identified in California and Texas several years earlier by Duffus and Liu (1991). The Salinas lab continues to study this new virus named "Beet chlorosis virus" (BChV), characterizing biological properties, including aphid transmission and host range, as well as molecular and serological aspects. Antiserum has been produced, and we are collaborating with European researchers to develop specific molecular probes for this virus that will differentiate it from other poleroviruses of sugarbeet. We are also collaborating with Dr. R. T. Lewellen in variety trials for resistance to this virus.

Objectives:
The objectives for this project in the past year were: (1) to use sequence information to begin development of nucleic acid probes to specifically detect BChV, BWYV and BMYV, (2) to continue sampling for this virus, and (3) to characterize the major components of the virus yellows complex and determine the interactions between the viral members of the complex that lead to increased disease severity and virus concentration.

Accomplishments:
(1) Probes were developed that specifically detect all virus groups associated with the virus yellows complex (BYV, the poleroviruses BWYV and BChV, and Beet mosaic potyvirus [BtMV]). We have obtained nearly the complete nucleotide sequence of BChV, and are using this information along with sequence information on BWYV and BMYV to develop

probes that are specific to each respective virus. To date, we have attempted to use PCR to differentially detect these viruses, but sequence similarity between the viruses has complicated these efforts. We are currently exploring a different approach involving short nucleic acid segments that will specifically bind to virus nucleic acids that exactly match the segments.

(2) We have continued to examine beet samples from throughout the western U.S. for the presence of BChV, but have not fully developed this aspect of the project because probes are not yet available to distinguish BChV from BWYV. BMYV has never been found in the U.S., but is included due to collaborators in Europe, and the desire to be able to monitor for this virus in case it ever does appear in the U.S. Although antiserum against BChV was produced last year, and initial tests suggested it would be effective in distinguishing BChV from BWYV, further testing demonstrated that this antiserum, like that for BWYV, will detect beet poleroviruses in general, but not BChV specifically. In addition, sequence data on BChV confirms this, since the viral coat protein sequence (the part the antiserum was made to detect) does not differ very much between BWYV and BChV.

Project 281

Investigations into: (1) The cause for decreased root and sugar yield in midwestern sugarbeet production and (2) The effect of mixed soil-borne virus infections on virus concentration and sugarbeet growth

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Research Sponsors:
The Western Sugar Company-Grower Joint Research Committee
Beet Sugar Development Foundation
California Beet Growers Association and California Industry Research Committee

Introduction:

A significant decrease in sugarbeet yield has been observed throughout the high plains sugarbeet production region for the past few years. Possible causes which have been suggested include Rhizomania (caused by *Beet necrotic yellow vein virus* [BNYVV]), selections of sugarbeet varieties which are not suited to the area in production, or soil-borne fungal, bacterial, and other viral pathogens. Our results suggest that Rhizomania is not the cause, and that other soil-borne sugar beet viruses may have an important role. Our preliminary results indicated that the soil-borne viruses of beet, in particular *Beet soil-borne mosaic virus* (BSBMV) and possibly *Beet soil-borne virus* (BSBV), are important factors in limiting beet production.

Objectives:

The objectives of this study during 2000 were to continue to study the effect of soil-borne viruses that may be associated with the decline. We wanted to: (1) identify additional fields affected by the yield decline, to prepare for a field trials to compare the effect of fumigation of beet production in the presence of BSBMV, and (2) evaluate the effect of mixed infections of BNYVV and BSBMV on beet production.

Accomplishments:

(1) Soil and sugarbeets were collected from numerous fields in western Nebraska and eastern Colorado. These samples were assayed for the presence of BNYVV (causal agent of rhizomania) and BSBMV using the standard ELISA test and associated procedures, including highly specific antisera (Table 1). The table is broken into three sections, as different sampling techniques were necessitated, based on the type of study being conducted (see italics, Table 1). A second sampling of some fields was obtained a month later, and results were consistent (data not shown). Finally, the soil baiting technique was used on soil samples from selected fields, and again results were consistent. Although several fields were identified that contained both viruses, only two additional fields were found that appeared to have only BSBMV. One of the fields will be used for a replicated, randomized trial to compare the effect of fumigation on beet production in the presence of BSBMV in the summer of 2001.

Table 1. Level of BNYVV and BSBMV in sugarbeet samples from Colorado and Nebraska fields exhibiting yield decline syndrome

Field	BNYVV OD/h	BSBMV OD/h
variety trial plots (average of 29 beets)		
Field 1	1.09	1.09
Field 2	1.05	1.09
Field 3	7.80	1.89
Field 4	1.04	1.01
Field 5	1.06	1.10
10 beet were used in a composite sample for each field		
Field 6	6.1	4.8
Field 7	1.08	2.86
Field 8	1.09	1.53
Field 9	1.39	11.68*
Field 10	2.73	7.47
Field 11	1.08	1.67
Field 12	0.98	1.03
Field 13	1.28	11.11*
soil baiting test from selected fields using sugarbeet seedlings to trap virus		
Field 7	1.1	1.09
Field 9	0.93	8.06*
Field 10	2.6	7.97
Field 13	1	7.1*
Field 14	0.93	1.15

- Samples with asterisk had high levels of BSBMV and little if any BNYVV. These fields have potential for field testing of the effect of BSBMV on sugarbeet production.
- Table is broken into three sections based on different sampling techniques used. Note that the results are the same regardless of whether soil baiting was used or if beets were sampled directly from the field.

(3) Two greenhouse trials comparing the effect of single and mixed infections of BNYVV and BSBMV, virus free *Polymyxa betae*, and virus free soil (initial test did not include virus free *P. betae*) were conducted. A third is in progress. Initial studies suggested that when mixed infections of BNYVV and BSBMV were compared to single infections in a susceptible sugarbeet line, the reactions, as measured by root symptoms and individual beet weight were more severe than each virus alone (Figure 1). A second study did not clearly confirm this finding, although it was not refuted either (Figure 2). We are awaiting the results of the current trial to ascertain whether or not this effect is common, but it is clear

by simply looking at beet plants that mixed infection causes a decrease in plant size compared with single infection of either virus (data not shown).

Virus concentrations were also affected in mixed infections of BNYVV and BSBMV. Results of initial studies on mixed infections in a susceptible sugarbeet variety demonstrated that BNYVV levels were higher in mixed infection with BSBMV than when beets were infected with BNYVV alone. In contrast, BSBMV levels were suppressed in mixed infection with BNYVV compared with plants infected with BSBMV alone (Figure 3). In a later study conducted in both susceptible and BNYVV resistant varieties (Holly Gene), however, it became apparent that the respective increases and decreases associated with BNYVV and BSBMV may not be associated with the virus itself, but rather the timing of infection. In the later study, BNYVV levels were highest in the single infection rather than the mixed infection in the susceptible variety (Figure 4). Although single infections produced higher virus levels, BNYVV still accumulated well in mixed infection, suggesting it is quite effective in competing with BSBMV for host-cell replication processes. Interestingly, BSBMV levels were again suppressed in mixed infection as they were in the initial experiment. BNYVV levels were suppressed quite effectively by the Holly Gene in the resistant variety, but as with the initial experiment, BNYVV levels were again highest in mixed infection by the end of the experiment (Figure 5).

This research clearly demonstrates that BSBMV infection does not moderate the effects of BNYVV. In two experiments, BNYVV levels were higher in mixed infection with BSBMV than with BNYVV alone (Figures 3 and 5). Even in the example in which the single infection had higher virus levels, BNYVV accumulated quite well (Figure 4). This confirms that BSBMV does not cross protect against BNYVV when both viruses are introduced into the plant from the soil by the fungal vector, *P. betae*, as occurs in naturally infested fields. Another important finding is that the resistance to BNYVV conferred by the Holly Gene does not confer resistance to BSBMV. This was demonstrated by suppressed BNYVV levels in the resistant variety Beta 4430, while BSBMV levels were able to accumulate equally well in the resistant Beta 4430, and susceptible varieties USH-11 and KW6770 (Figures 3, 4 and 5). This demonstrates a need for additional sources of resistance against BSBMV.

Although the exact role of BSBMV in the yield decline syndrome is still being determined, our recommendation remains the same. Growers should use the same precautions in handling fields infested with BSBMV as would be used for BNYVV to prevent further spread of soil-borne viruses.

Figure 1

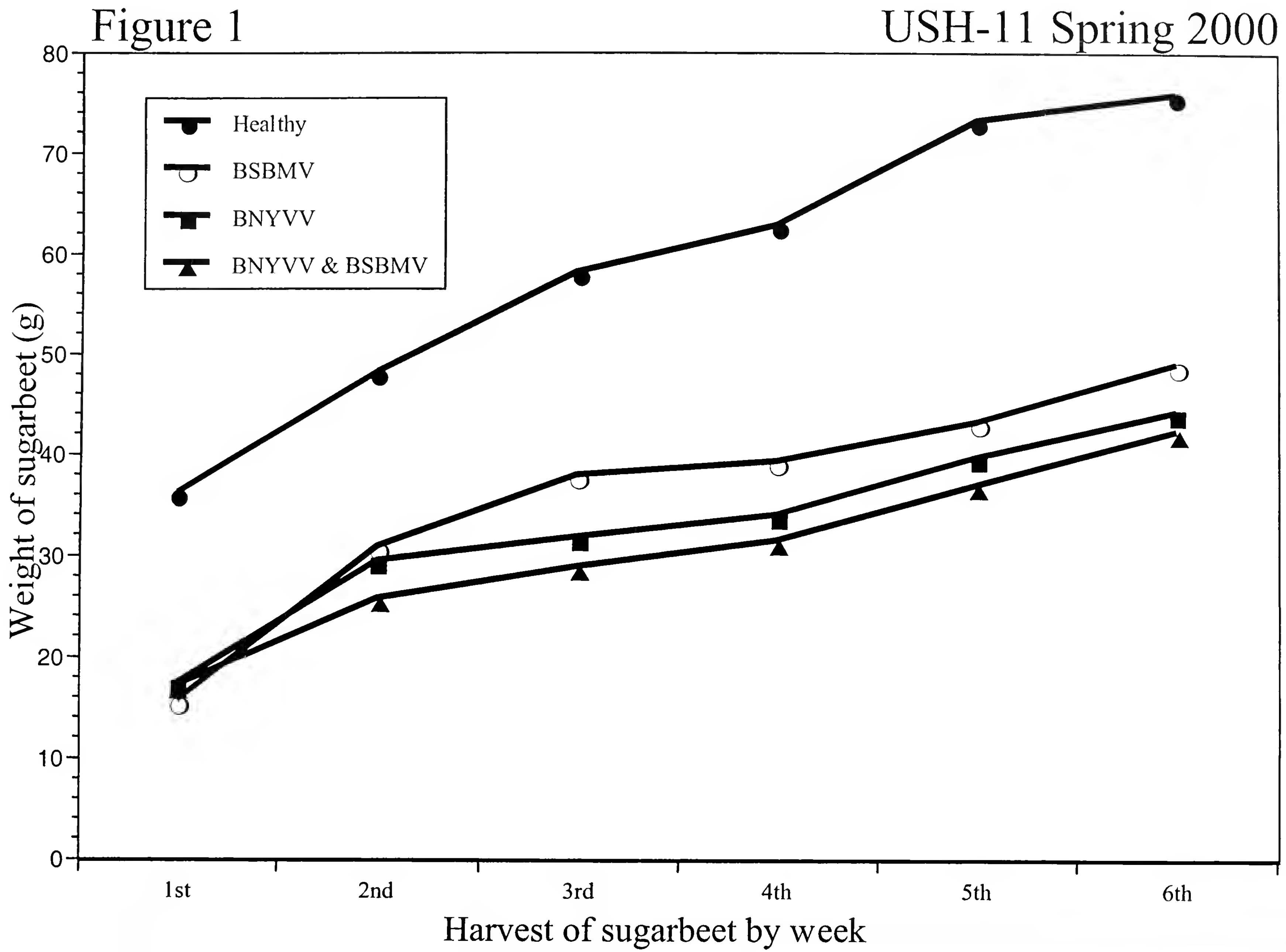

USH-11 Spring 2000
Healthy
BSBMV
BNYVV
BNYVV & BSBMV
Weight of sugarbeet (g)
0
10
20
30
40
50
60
70
80
1st
2nd
3rd
4th
5th
6th
Harvest of sugarbeet by week

Figure 2

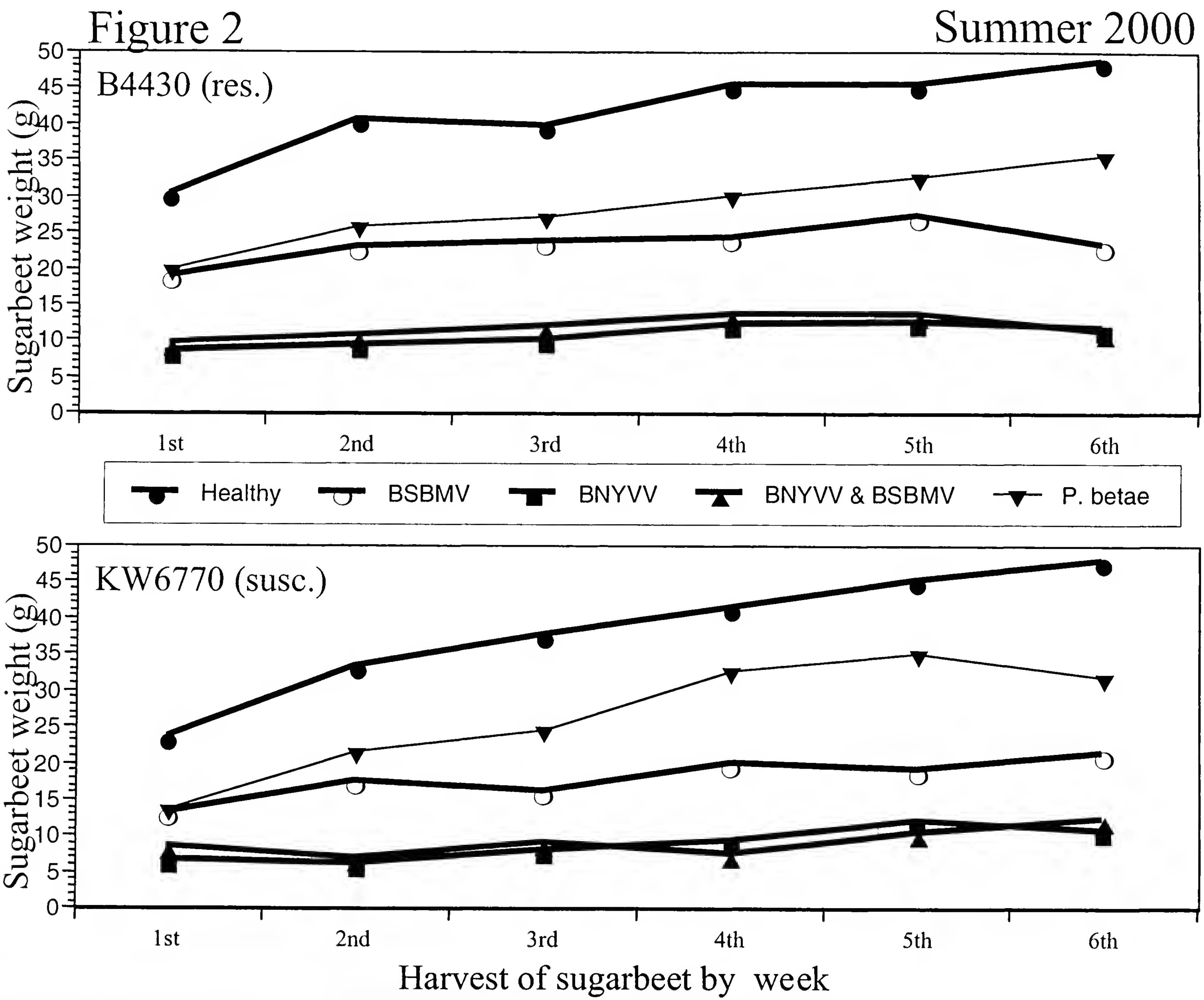

Summer 2000
B4430 (res.)
Sugarbeet weight (g)
0
5
10
15
20
25
30
35
40
45
50
1st
2nd
3rd
4th
5th
6th
Healthy
BSBMV
BNYVV
BNYVV & BSBMV
P. betae
KW6770 (susc.)
Harvest of sugarbeet by week

Figure 3

USH-11 Spring 2000

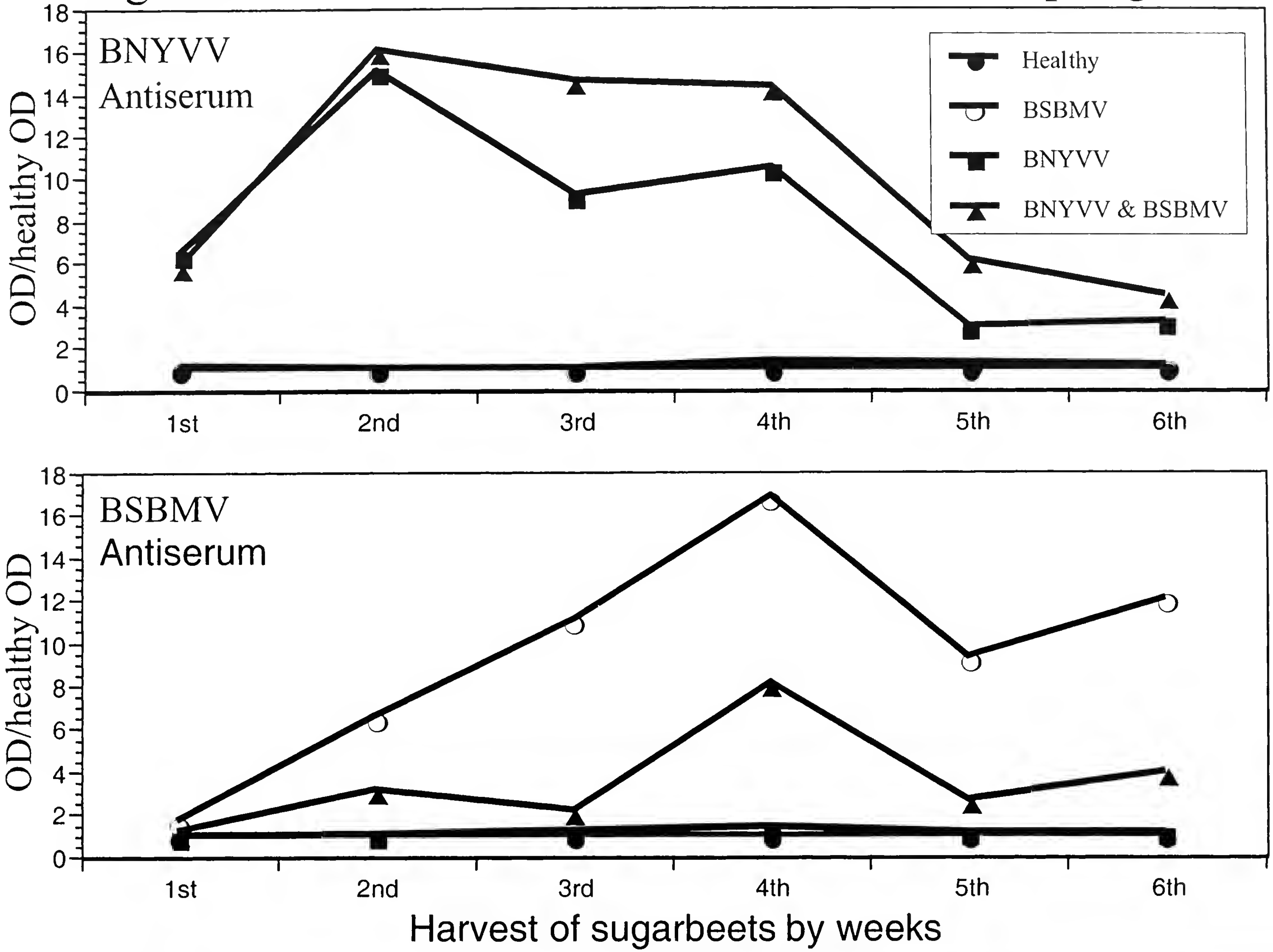


Figure 4 KW6770 Summer 2000

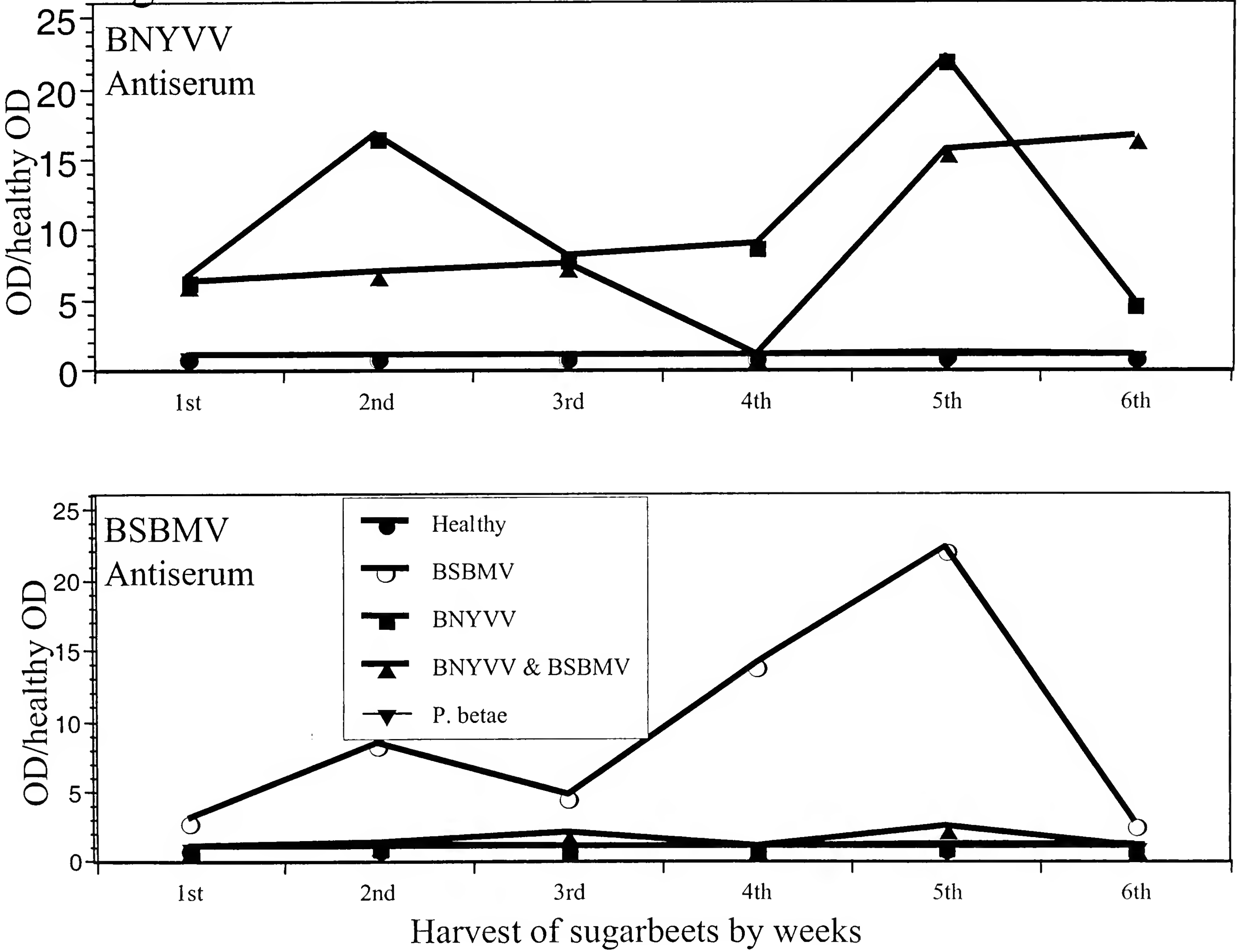
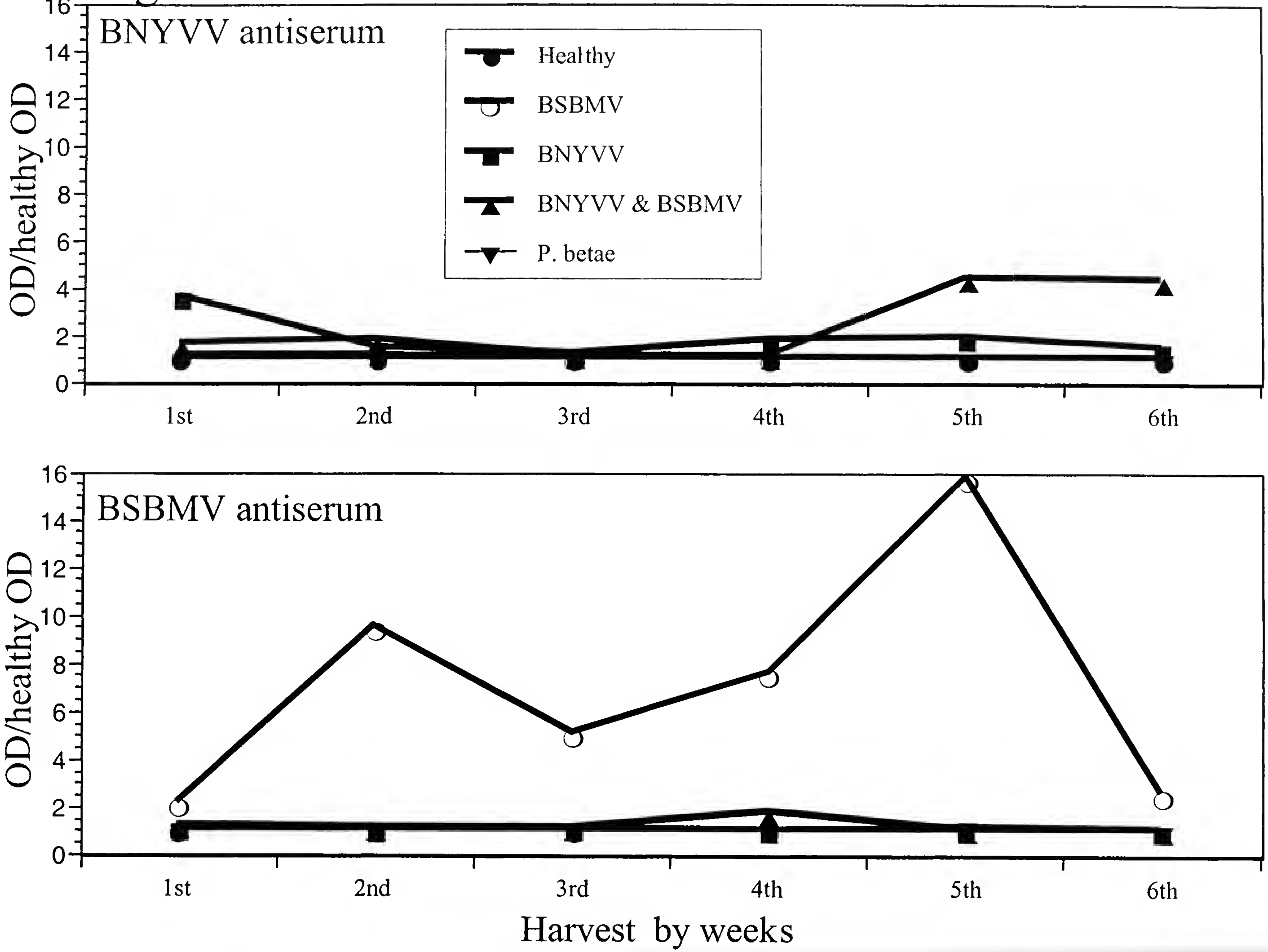


Figure 5

B4430 Summer 2000



DEVELOPMENT OF SUGARBEET BREEDING LINES AND GERMPLASM

R.T. LEWELLEN

CZ25-9 - Sugarbeet (*Beta vulgaris* L.) germplasm line CZ25-9 (PI615520) was released in 2001. CZ25-9 is a high sucrose concentration, narrowly based, multigerm (MM), self-fertile (S^f), red hypocotyl (*RR*) line that segregates for genetic male sterility (*aa*). It segregates for the *Rz* allele for resistance to rhizomania, caused by beet necrotic yellow vein virus. In tests at Salinas and Brawley, CA, CZ25-9 was intermediate to moderately susceptible for reaction to sugarbeet *Erwinia*, powdery mildew caused by *Erysiphe polygoni*, curly top virus, and virus yellows. It is intermediate in bolting tendency and resistant to downy mildew, caused by *Peronospora farinosa*. As a line, it has an intermediate sized canopy that is lighter green than most Salinas developed germplasm and trends toward being yellowish late in the season.

CZ25-9 is approximately 50% high sugar Polish germplasm and 50% population 912. Population 912 was developed at Salinas and segregates for self-fertility, genetic male sterility, and resistance to rhizomania. Population 912 is similar to population C918 (PI578079) (1) released in 1993. The Polish component was from 2n = 2x = 18, multigerm, S^sS^s, type-ZZ lines accessed from Dr. H. Szreder, Hodowla Buraka Cukrowego, Poland, in 1988 for use in the Salinas breeding program. A composite of the nine Polish accessions was crossed to genetic male-sterile plants from population 912. Plants from the F_1 population were selected for resistance to rhizomania and increased in bulk. Depending upon the segregation for self-sterility, the F_2 would have been derived by either selfing or sib mating. Thus, recombination was incomplete. Plants from within the F_2 line were selected for resistance to rhizomania and plant type and bulk increased. Again F_3 individuals could have resulted from selfing or sibbing, depending upon segregation for self-sterility and genetic male sterility, and could potentially have been S_o's, S_1's, or S_2's. The F_3 was called Z325 and was one of the components of the population released as CZ25 (PI599343) (1). Randomly selected pollen fertile plants from Z325 were individually selfed under paper bags in the greenhouse to produce selfed progeny families. Individual plants would have descended from as few as two plants or through recombination, from as many as 16 initial parental plants. Based upon per se performance for resistance to rhizomania and sucrose concentration, line Z625-9 was selected, increased to produce line Z825-9, and topcrossed to a monogerm tester. Based upon its superior hybrid performance for sugar yield and sucrose concentration, line Z825-9 was increased to produce line Z025-9. Line Z025-9 is being released as CZ25-9. Distributed seed was produced on the genetic male-sterile segregants within line Z825-9.

CZ25-9 should be evaluated as a potential pollinator to produce high sugar hybrids where resistance to rhizomania is needed but high resistance to other diseases is not. It could be useful also as a high sugar, rhizomania resistant source line for further improvement of sugarbeet. CZ25-9 has a substantially different genetic background than lines traditionally released from the Salinas program (2).

References and Notes

1. National Germplasm Resources Laboratory, Beltsville, MD. www.ars-grin.gov/npgs/searchgrin.html
2. Lewellen, R. T. 1993. Use of plant introductions to improve populations and hybrids of sugarbeet. P. 117-136. *In* Use of plant introductions in cultivar development. Part 2, CSSA Special Publ. 20. CSSA, Madison, WI.

CR09-1 - Sugarbeet (*Beta vulgaris* L.) germplasm line CR09-1 (PI615521) was released in 2001. CR09-1 is a narrowly based, multigerm (*MM*), self-fertile (S^f), red hypocotyl (*RR*) line that segregates for genetic male sterility. It segregates for the *Rz* allele for resistance to rhizomania, caused by beet necrotic yellow vein virus. In addition, the resistance to rhizomania found in line C79-6 may occur (1). CR09-1 has fair to moderate resistance to cercospora leaf spot, caused by *Cercospora beticola*, based upon nursery tests at Salinas, CA, Fort Collins, CO, and Shakopee, MN. CR09-1 has moderate resistance to sugarbeet *Erwinia* and downy mildew, caused by *Peronospora farinosa*. It has an intermediate reaction to bolting, curly top virus, powdery mildew, caused by *Erysiphe polygoni*, and virus yellows complex caused by beet yellows and beet western yellows viruses. In bolted, seed production phase, CR09-1 has a tendency for plant loss due to a crown rot of unknown cause. This crown rot has not been observed in the vegetative rosette stage or in its experimental hybrids. As a line, CR09-1 has a small canopy with erect leaves and only fair vigor and seed yield potential. Its experimental hybrids have large, upright canopies.

CR09-1 was isolated from a population similar to CR09 (PI593692) (2) released in 1996. An Italian accession with resistance to cercospora leaf spot and rhizomania called R05 was obtained from E. Biancardi at Rovigo, Italy, in 1987. This accessed line was crossed to Salinas population 747 that has good resistance to curly top, Erwinia, virus yellows, and bolting. After one cycle of recombination, stecklings from this F_2 were crossed to population 918 (PI578079) (2). Population 918 is similar to 747 but has resistance to rhizomania. After one cycle of full-sib family selection for combined resistance to rhizomania and cercospora leaf spot, the synthetic R409 was produced. Individual plants from R409 were selfed to produce S_1 progeny. These S_1 progeny families were evaluated for dual resistance to rhizomania and cercospora leaf spot at Salinas. The increase of one of the families with the best combination of disease resistance and agronomic traits was called R709-1. One additional cycle of mass selection for resistance to rhizomania was made within this line to produce line CR909-1. CR901-1 was increased through segregating genetic-male-sterile plants to produce line CR009-1, released as CR09-1.

At the same time that the bulk increases of this line were being made, it was crossed to a monogerm, cytoplasmic-male-sterile tester. Productions of this testcross hybrid were evaluated in disease and yield trials at Salinas and Brawley, CA. These trials showed that CR09-1 has good combining ability for sugar yield with intermediate sucrose concentration.

CR09-1 may be useful as a germplasm source for further improvements in resistance to cercospora leaf spot combined with other diseases. It needs to be evaluated as a potential pollinator of commercial hybrids where dual resistance to rhizomania and *Cercospora* are needed. Because the source of resistance to *Cercospora* is from a recent Italian accession, it may be of interest to determine if this resistance is the same as in the traditional USDA *Cercospora*

resistant base or if CR09-1 may contribute new and complementary genes to *Cercospora* resistant breeding programs.

References and Notes

1. Lewellen, R.T. 1997. Registration of 11 sugarbeet germplasm C79 lines with resistance to rhizomania. Crop Sci. 37:1026.
2. National Germplasm Resources Laboratory, Beltsville, MD. www.ars-grin.gov/npgs/searchgrin.html

C833-5 & C833-5CMS - Sugarbeet (*Beta vulgaris* L.) parental lines C833-5 (PI615522) and C833-5CMS (PI615523) were released in 2001. C833-5 is a narrowly based, self-fertile (S^f), red hypocotyl (*RR*), monogerm (*mm*), O-type line that segregates for genetic male sterility (*aa*). It has a high frequency of the *Rz* allele for resistance to rhizomania, caused by beet necrotic yellow vein virus. C833-5 is moderately resistant to bolting and sugarbeet *Erwinia*. It has intermediate resistance to curly top virus, powdery mildew, caused by *Erysiphe polygoni*, and downy mildew, caused by *Peronospora farinosa*. Relative to current commercial hybrids, hybrids with C833-5 perform best under virus yellows infected conditions. To its experimental hybrids, it confers good sucrose concentration and sugar yield. As a line, it has a small, compact, dark green canopy. The reactions of C833-5 to *Cercospora beticola*, *Rhizoctonia solani*, and *Aphanomyces cochliodies* are unknown.

C833-5 was extracted from the initial composite cross used to develop population 833. Population 833 was produced by crossing rhizomania resistant, monogerm, genetic male-sterile plants from population 867 with a composite of monogerm, O-type, nonbolting, curly top resistant inbred lines. These lines included C562 (PI590847), C546 (PI590649), C718 (PI590849), C762-17 (PI560130), C790-15 (PI564758), C790-68 (PI590790), C766-62 (PI560133), C767-46 (PI560132), and C796-43 (PI560133) (1). From the initial F_1, rhizomania resistant, monogerm plants were selected and selfed to create selfed progeny lines. Each S_1 family was rogued to genetic male-sterile plants and topcrossed. These topcross hybrids were evaluated in replicated yield and disease evaluation trials. On the basis of these trials, S_1 5833-5 was identified. Plants from 5833-5 were selfed and simultaneously crossed to an annual, male-sterile, O-type tester. Individual S_2 lines were evaluated for resistance to rhizomania and putative homozygous *RzRz* lines identified. The S_2 families that appeared to be O-type and *RzRz* were composited and increased through the segregating genetic male-sterile plants to produce line 0833-5. Line 0833-5 is being released as C833-5. In addition, a near-cytoplasmic-male-sterile equivalent, C833-5CMS, was released. C833-5CMS resulted from the second backcross of C833-5 to the F_1 hybrid C790-15CMS x 5833-5. C833-5CMS has been evaluated as breeding lines 9833-5H0 and 0833-5H0.

C833-5 traces from one fertile (Aa), S_o plant from the composite cross to produce population 833. It is unknown what monogerm, inbred line contributed the male gamete to produce this plant. Because C833-5 is homozygous for red hypocotyls color, all potential sources can probably be eliminated except C790-15 (2) or C790-68 (3).

Although C833-5 nor C833-5CMS is yet used in commercial hybrids, their performance in experimental hybrids and combined disease resistance make them potential candidates for use as a parental line. C833-5 may be useful as a source for continued line improvement.

References and Notes

1. National Germplasm Resources Laboratory, Beltsville, MD. www.ars-grin.gov/npgs/searchgrin.html
2. Lewellen, R. T. 1994. Registration of C790-6, C790-15, and C790-54 parental lines of sugarbeet. Crop Sci. 34:319-320.
3. Lewellen, R.T., and I.O. Skoyen. 1987. Registration of 17 monogerm, self-fertile germplasm lines of sugarbeet derived from three random-mating populations. Crop Sci. 27:371-372.

INDEX OF VARIETY TRIALS, SALINAS, CA, 2000
U.S. AGRICULTURAL RESEARCH STATION

Tests were located in three field plot areas at Salinas and two at Brawley, CA. Disease nurseries were also used in Idaho, Colorado, and Minnesota. Tests at Brawley (Imperial Valley) were planted in September 1999, and harvested from May through July, 2000. Tests at Salinas were planted from November, 1999 through August, 2000, and harvested from September through December. Tests at Spence Field (Salinas) were under both rhizomania and nonrhizomania (following methyl bromide fumigation) conditions. Herbicides were not used in Block 6 trials that followed strawberries and methyl bromide fumigation. Nortron, Pyramin, Betamix, Progress, and Poast were used in the other trials. Bayleton at 2lbs material/acre was used for powdery mildew control. Lorsban-4E was applied for aphid and other insect control. The specific planting and harvest dates as well as plot size and design are shown on each test summary.

Tests are listed in the main Table of Contents for Salinas by types of material and evaluation. As an aid to find test summaries, they are listed below by ascending test (planting date) number and cross- referenced to the page number. Tests shown as N/A are not available or not included in this report.

TEST NO.	NO. ENTRIES	TEST DESCRIPTION	PAGE NO.
YIELD TRIALS OF PROGENY BLOCK 6, PLANTED MARCH 2000			
1300	64	Full-sib progeny from C78 & C80	n/a
1400	112	Full-sib progeny from C69,Y68,etc.	n/a
1500	48	Full-sib progeny from C67,Y72,Y75	n/a
1600	64	S_1 progeny from MM,S^f,Aa populations	n/a
1700	32	S_1 progeny from MM, S^f,Aa, *Bvm* populations	n/a
1800	128	S_1 progeny from populations 931,Z31	n/a
2100	32	Evaluation of selected S_1 MM lines	A202

YIELD TRIALS, BLOCK 6, PLANTED MARCH 2000

Note: In 2000, virus yellows inoculations could not be made due to problems rearing aphids, so VY inoculated: noninoculated companion tests were combined.

TEST NO.	NO. ENTRIES	TEST DESCRIPTION	PAGE NO.
2200 & 2500	48	Evaluation of breeding lines	A39
2300 & 2600	24	Evaluation of CA & CO Commercial hybrids	A51
2400 & 2700	12	Evaluation of experimental hybrids	A53
2800	24	Evaluation of monogerm lines & populations	A47
2900	48	Evaluation of testcross hybrids	A54
3000	48	Evaluation of hybrids with selected S_1 lines	A57
3100	72	Screen of S_1 mmaa x Tester hybrids	A60
3200	16	Retest of S_1 mmaa x T from 1999	A64
3300	48	Evaluation of experimental hybrids	A65
3400	36	Screen of S_2 mmaa x Tester hybrids	A69
3500	40	BChV evaluation of BTS entries	n/a
DISEASE EVALUATION TRIALS, BLOCK 4, PLANTED APRIL 2000			
4100	198	Inheritance of resistance to powdery mildew (Note: Published in PLANT DISEASE, V85, 2001)	n/a
4200	48	CBGA Coded Powdery Mildew	A143
4300	80	Erwinia/Powdery Mildew eval. MM lines	A136
4400	40	Erwinia/Powdery Mildew eval. S_1 lines	A139
4500	40	Erwinia/Powdery Mildew eval. mm lines	A141
4600	48	Yield & Cercospora eval. lines & hybrids	A146
4700	84	Half-sib progeny eval. for Cercospora (Checks)	A149
4800	148	S_1 progeny eval. for Cercospora	n/a
TRIALS UNDER RHIZOMANIA, BLOCK 2N, PLANTED APRIL 2000 EVALUATION & SELECTION			
4900	18	Mother root selection (RZM-ER-%S)	n/a
5000	8	Seedex selection & evaluation	n/a
5100	48	Plant introductions (CGC entries)	n/a

TEST 2100. EVALUATION OF MULTIGERM PROGENY LINES, SALINAS, CA., 2000

32 entries x 6 reps., RCB
1-row plots, 11 ft. long

Planted: March 23, 2000
Harvested: October 5, 2000

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/100'	Root Rot	RJAP	Powdery Mildew		
		Lbs	Tons	%	No.	%	%	10/2	10/4	Mean
Checks										
97-SP22-0	Inc. SP7622-0	14794	47.69	15.47	144	1.0	85.1	5.7	5.3	5.5
R776-89-5NB	Inc. R576-89-5NB,(C76-89-5)	14621	43.11	16.95	144	0.0	81.6	4.5	2.5	3.5
9924	RZM 8924aa x A	17849	53.62	16.68	139	0.0	83.5	5.0	4.5	4.8
9931R	ZM 8931aa x A	19149	59.44	16.12	139	0.0	82.1	5.0	4.2	4.6
Progeny Lines										
9924- 2	Inc. 7924-2,(5924)	15041	43.66	17.23	132	0.0	82.1	4.0	1.5	2.8
9924- 6	Inc. 7924-6,(5924)	16275	48.96	16.63	126	0.0	83.8	4.7	4.2	4.4
9924-10	Inc. 7924-10,(5924)	16361	48.44	16.88	130	0.0	84.0	5.7	4.8	5.3
9924-74	Inc. 7924-74%,(5924)	16051	46.08	17.43	136	0.0	84.7	5.5	6.5	6.0
9924-77	Inc. 7924-77,(5924)	18825	53.98	17.43	139	0.0	82.9	4.7	3.2	3.9
9924-78	Inc. 7924-78,(5924)	16110	44.06	18.28	147	0.0	81.6	5.7	5.8	5.8
9924-114	Inc. 7924-114,(5924)	16364	47.61	17.17	129	0.0	82.1	5.2	4.0	4.6
9931-18	Inc. 7931-18,(6931)	15256	45.43	16.80	135	0.0	81.5	3.7	1.3	2.5
9931-24	Inc. 7931-24,(6931)	14364	42.72	16.82	135	0.0	80.5	4.8	3.8	4.3
9931-29	Inc. 7931-29,(6931)	15399	46.11	16.68	132	0.0	81.8	5.2	4.5	4.8
9929- 4	Inc. 7929-4VY,(R581H18)	14049	43.73	16.05	133	0.0	80.3	3.8	2.0	2.9
9929- 9	Inc. 7929-9VY,(R581H18)	14382	44.48	16.18	136	0.0	81.1	4.5	2.5	3.5
9929-45	Inc. 7929-45VY,(R576-89-18H18)	15215	46.69	16.13	138	0.0	82.8	5.0	5.2	5.1
9929-47	Inc. 7929-47VY,(R576-89-18H18)	13731	42.64	16.10	132	0.0	80.1	5.8	6.0	5.9
9929-48	Inc. 7929-48VY,(R576-89-18H18)	14100	40.57	17.38	133	0.0	82.2	5.0	2.8	3.9
9929-56	Inc. 7929-56VY,(R576-89-18H18)	11304	34.93	16.18	139	0.0	83.8	4.8	3.3	4.1
9929-62	Inc. 7929-62,(R576-89-18H18)	16189	51.98	15.55	133	2.4	82.4	4.0	1.7	2.8
9930-17	Inc. 7930-17VY,(R578H18)	13897	42.06	16.48	138	0.0	84.4	4.5	3.8	4.2
9930-32	Inc. 7930-32,(R678H5)	13856	41.86	16.57	136	0.0	80.6	4.0	1.7	2.8
9930-35	Inc. 7930-35,(R678H5)	14365	41.37	17.38	147	0.0	82.6	6.2	6.2	6.2

TEST 2100. EVALUATION OF MULTIGERM PROGENY LINES, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %	Powdery Mildew 10/2	Powdery Mildew 10/4	Powdery Mildew Mean
Progeny Lines (cont.)										
9927- 4	Inc. 7927-4VY, (5921H18)	17266	53.81	16.03	138	0.0	83.1	6.3	7.7	7.0
9927-17	Inc. 7927-17VY, (5921H18)	16249	52.17	15.55	136	0.0	83.2	4.3	4.7	4.5
9928-34	Inc. 7928-34, (6921H25)	16565	51.61	16.07	135	0.0	82.5	4.8	5.5	5.2
9928-107	Inc. 7928-107, (Y671H15)	16658	51.04	16.30	138	0.0	80.6	4.8	4.2	4.5
Retest of Progeny Lines										
R976-89-18	Inc. R576-89-18,NB,(C76-89-18)	15196	48.62	15.55	133	0.0	82.3	4.7	4.0	4.3
8913-70	RZM-ER-% 6913-70, (C913-70)	15603	47.79	16.33	159	0.0	82.0	4.7	4.7	4.7
8918-12	RZM-ER-% 6918-12	16462	51.19	16.10	144	0.0	81.9	3.5	0.7	2.1
9719*Bm*	Inc. 6719 (C719*Bm*), (C719)	14550	44.82	16.25	152	0.0	85.7	6.0	7.2	6.6
Mean		15503.0	46.95	16.52	137.8	0.1	82.5	4.9	4.1	4.5
LSD (.05)		2219.1	6.08	0.86	12.3	0.9	2.7	0.8	1.5	1.1
C.V. (%)		12.6	11.36	4.55	7.8	736.5	2.9	15.3	33.4	21.3
F value		3.9**	5.30**	4.59**	2.4**	2.0**	2.1**	5.6**	10.1**	9.8**

NOTES: Test 2100 was originally planned to evaluate selected progeny lines under VY (BChV) conditions. BChV inoculations could not be made. There was probably mild BWYV natural infection based upon foliar symptoms in VYS check SP22-0. See test 6300 for the performance of these lines under rhizomania and test 3000 & 6900 for performance in testcross hybrids. See tests B300 and B600 for performance in Imperial Valley.

From MM,S^f,A:aa,*Rz* populations, Aa mother roots were selected on the basis of resistance to rhizomania, etc. and individually selfed. The S_1 progenies were evaluated in 1998. Selected S_1 progenies were individually increased in 1999 & crossed to a CMS tester. These increased progeny lines and their hybrids are being evaluated in 2000.

TEST 2200-2500. PERFORMANCE OF LINES UNDER/WITHOUT VIRUS YELLOWS INFECTION, SALINAS, CA., 2000

48 entries x 16 reps., RCB, 3 subtests: 16 x 16, RCB
1-row plots, 22 ft. long

Planted: March 23, 2000
Harvested: October 2-5, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Root Rot %	RJAP %	Powdery Mildew Score
2200-2500-1:	Multigerm, O.P. Lines								
KW6770	Susc. check, 1997	17367	45.55	19.05	156	0.0	0.6	85.9	4.6
97-US22/3	Inc. Y009 (US22/3)	13795	40.80	16.90	153	0.4	0.2	82.3	6.5
97-US75	Inc. 268 (US75)	14519	47.77	15.23	158	0.0	0.0	82.6	6.9
99-C37	Inc. U86-37, (C37)	15483	47.36	16.35	156	0.0	0.0	82.8	7.9
99-C46/2	Inc. U86-46/2, (C46/2)	16507	49.76	16.60	153	0.0	0.0	83.0	3.9
R978	RZM-ER-% R778,%, (C78)	17025	50.69	16.80	151	0.0	0.0	82.8	3.4
R980	RZM-ER-% R780/2, R780-45, (C80)	17370	50.51	17.22	155	0.0	0.0	83.6	4.4
R639	RZM R539, (C39R)	15630	48.15	16.24	151	0.0	0.0	83.7	3.7
Y969(Iso)	RZM-ER-% Y769, (C69)	17573	50.84	17.29	153	0.0	0.0	82.7	3.2
99-C31/6	Inc. F86-31/6, (C31/6)	16270	49.00	16.59	156	0.0	0.0	81.9	3.9
R881	RZM R776,R781,R781-43,(C82)	16559	51.50	16.09	153	0.0	0.0	84.2	4.8
R882	Inc. R781, R776,R781-43,(C82)	15924	51.27	15.52	153	0.0	0.0	83.5	4.3
97-SP22-O	Inc. SP7622-0	13772	42.90	16.06	155	0.0	0.2	83.4	4.9
R776-89-5NB	Inc. R576-89-5NB,(C76-89-5)	14292	41.95	17.05	145	0.0	0.0	82.9	3.1
R976-89-18	Inc. R576-89-18,(C76-89-18)	15201	46.45	16.36	139	0.5	0.0	83.5	4.1
R970	RZM-ER-% R770	16703	50.64	16.51	154	0.0	0.0	82.7	4.6
Mean		15874.4	47.82	16.62	152.6	0.1	0.1	83.2	4.7
LSD (.05)		820.9	2.30	0.41	6.3	0.4	0.3	1.2	0.8
C.V. (%)		7.4	6.90	3.55	5.9	1036.7	693.8	2.1	23.5
F value		18.6**	17.47**	33.87**	4.4**	1.1NS	2.2**	4.4**	25.0**

TEST 2200-2500. PERFORMANCE OF LINES UNDER/WITHOUT VIRUS YELLOWS INFECTION, SALINAS, CA., 2000
48 entries x 16 reps., RCB. ANOVA across tests to compare means.

	Sugar Lbs	Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Root Rot %	RJAP %	Powdery Mildew Score
Mean	16560.6	50.08	16.54	155.4	0.3	0.1	83.0	4.8
LSD (.05)	853.1	2.43	0.38	6.8	0.7	0.3	1.3	0.8
C.V.(%)	7.4	7.00	3.33	6.3	382.6	869.1	2.3	22.7
F value	20.1**	20.03**	18.73**	4.4**	25.5**	1.4*	4.9**	21.9**

TEST 2200-2500. PERFORMANCE OF LINES UNDER/WITHOUT VIRUS YELLOWS INFECTION, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Root Rot %	RJAP %	Powdery Mildew Score
2200-2500-2:	Multigerm lines with *Bvm* germplasm								
Beta 4776R	4776.9002 (4776RFA2),9-8-99	18734	53.51	17.52	165	0.0	0.4	85.3	3.8
R926	RZM R826 (C26)	14977	46.81	15.99	151	0.0	0.0	81.6	7.1
R927	RZM R827 (C27)	17120	51.80	16.54	159	0.0	0.0	83.1	5.3
Y967	RZM-ER-% Y767(Iso),(C67)	16703	49.63	16.83	156	0.0	0.2	82.9	3.9
Y971	RZM-ER-% Y771(Iso)	16631	50.64	16.42	157	0.0	0.0	83.6	5.7
Y975	RZM Y875	17087	51.57	16.57	156	0.0	0.0	83.9	5.3
R943	RZM-ER-% R643	16458	50.06	16.43	145	0.0	0.0	81.6	5.8
R940	RZM-ER-% R740(C79-#)	16912	52.30	16.16	156	0.0	0.0	83.0	4.8
R936	RZM-ER-% R736(C79-8,R22)	15954	50.31	15.86	155	0.0	0.0	83.0	7.3
P907	RZM-PMR P807,P808,F_2[C78x(Y71xPMR)]	16605	51.07	16.27	157	0.0	0.0	82.2	3.7
P909	RZM-PMR P809,P810,F_2[C78x(C79xPMR)]	17503	54.55	16.03	148	3.5	0.0	82.8	4.1
P915	RZM-PMR P815,P816,F_2(C78xP603,P604)	18416	56.82	16.22	158	8.5	0.0	83.0	4.1
CR909-1	RZM R709-1	13220	39.76	16.63	154	0.0	0.0	79.5	4.8
CR910	RZM R710,R709-9,R710-10,R710-14	15643	48.57	16.11	154	0.0	0.0	82.8	5.3
CR911(C)	CR811(C)aa x A, (CR09,10)	17147	52.45	16.34	152	0.0	0.0	82.1	5.5
Rifle	Spreckels, 1999	17567	50.61	17.36	155	0.0	0.2	83.5	5.3
Mean		16667.2	50.65	16.46	154.9	0.8	0.1	82.8	5.1
LSD (.05)		897.0	2.56	0.38	5.4	1.2	0.4	1.6	0.7
C.V. (%)		7.7	7.25	3.34	5.0	225.7	1018.4	2.7	19.0
F value		16.6**	16.51**	11.29**	5.5**	28.1**	0.9NS	4.9**	19.3**

TEST 2200-2500. PERFORMANCE OF LINES UNDER/WITHOUT VIRUS YELLOWS INFECTION, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Root Rot %	RJAP %	Powdery Mildew Score
2200-2500-3: Multigerm, S^f,A:aa popns & lines									
Beta 4430R	L4430.8052, rec'd 3-10-99	19721	57.37	17.19	169	0.0	0.0	85.7	3.6
Z925	RZM-ER-% Z725(C), (%S)	17064	48.72	17.52	157	0.0	0.0	83.5	4.9
9924	RZM 8924aa x A, (VY)	17885	54.64	16.39	156	0.2	0.0	83.6	4.4
9926	8926aa x A, (RZM-*Bvm*)	18071	55.10	16.40	157	0.0	0.0	82.8	4.1
9931	RZM 8931aa x A, (base popn)	18552	56.08	16.54	158	0.0	0.0	83.0	4.1
9932	RZM 8932aa x A, (CTR,%S)	17256	53.06	16.27	150	0.0	0.0	83.5	6.1
9933	8933aa x A, (Root aphid, *Rz*)	18603	56.61	16.45	159	0.0	0.0	83.6	4.3
9934	RZM 8934(C), (VT,*Rz*,*Bvm*)	16769	51.52	16.29	163	0.0	0.0	83.2	5.3
9941	941(C)aa x A, (VY-*Rz*)	17592	53.03	16.59	157	0.0	0.0	82.8	3.9
8935(Sp)	Inc. R776-89-5H13(Aa)	15058	46.53	16.18	157	0.0	0.0	82.7	4.1
8936	RZM R776-89-5H31(Aa)	16958	50.26	16.87	156	0.0	0.0	83.7	3.8
8937	RZM R776-89-5H11(Aa)	16313	48.70	16.77	157	0.0	0.0	83.2	3.5
8939	RZM Y769H31(Aa)	17276	52.45	16.47	159	0.0	0.0	83.1	3.4
8913-70	RZM-ER-% 6913-70, (C913-70)	14791	46.31	15.98	163	0.0	0.0	81.3	3.6
9836	RZM 8836, (mm,T-O,VY)	15399	46.43	16.59	163	0.0	0.2	81.1	8.1
9835	8835mmaa x A, (mm,T-O,CT)	16934	51.50	16.46	161	0.0	0.4	83.4	7.4
Mean		17140.1	51.77	16.56	158.8	0.0	0.0	83.1	4.7
LSD (.05)		840.1	2.44	0.34	5.5	0.1	0.2	1.1	0.7
C.V. (%)		7.0	6.78	2.93	5.0	1600.00	905.7	2.0	21.2
F value		19.3**	17.61**	10.01**	4.7**	1.0NS	1.7NS	6.3**	32.0**

NOTES: See notes for tests 2300 & 2600. That is, because we failed to make BChV inoculations, tests 2200 & 2500 were combined into a single test with 48V x 16R. Tests 2200 & 2500-3 primarily evaluated MM,self-fertile(S^f), A:aa populations and lines. 9931 = base popn undergoing improvement and was used as a major component to develop most of the other populations: CR910 and CR911 have resistance to Cercospora introgressed; Z925 has high %S germplasm from Polish sources; 9926 has rhizomania resistance from C51 (*Bvm*); emphasis for VYR has been made for 9924; emphasis for CTR for 9932; root aphid resistance for 9933; etc. Populations 9836 and 9835 are monogerms. See test 6500 for performance under rhizomania.

TEST 6300. RHIZOMANIA EVALUATION OF MULTIGERM PROGENY LINES, SALINAS, CA., 2000

32 entries x 3 reps., sequential
1-row plots, 22 ft. long

Planted: May 24, 2000
Harvested: November 9, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	RJAP %
Checks						
Beta 4776R	Betaseed, resist. ck, 9-8-99	13259	37.94	17.50	179	88.3
US H11	1999 prod., susc. ck	4835	15.91	15.13	176	83.8
R976-89-18	Inc. R576-89-18 (C76-89-18)	7115	20.75	17.13	164	85.3
Z825-9	Inc. Z625-9(A,aa),(Z325)	7320	19.86	18.40	165	80.0
Progeny Lines						
9924 - 2	Inc. 7924-2, (5924)	7325	20.37	18.00	159	83.7
9924 - 6	Inc. 7924-6, (5924)	5739	17.27	16.70	170	82.7
9924 -10	Inc. 7924-10, (5924)	10575	30.32	17.43	156	84.4
9924 -74	Inc. 7924-74%, (5924)	6743	19.63	17.23	150	82.8
9924 -77	Inc. 7924-77, (5924)	10110	27.37	18.47	165	83.1
9924 -78	Inc. 7924-78, (5924)	5367	15.91	16.57	156	75.9
9924 -114	Inc. 7924-114, (5924)	6630	17.85	18.57	145	83.9
9931 -18	Inc. 7931-18, (6931)	6759	18.71	18.00	176	83.2
9931 -24	Inc. 7931-24, (6931)	5424	14.95	18.17	159	81.6
9931 -29	Inc. 7931-29, (6931)	5904	17.19	17.17	155	83.9
9929 - 4	Inc. 7929-4VY, (R581H18)	6296	17.19	18.37	168	81.0
9929 - 9	Inc. 7929-9VY, (R581H18)	9238	26.90	17.17	171	85.7
9929 -45	Inc. 7929-45VY, (R576-89-18H18)	6333	17.71	17.97	144	85.4
9929 -47	Inc. 7929-47VY, (R576-89-18H18)	3374	9.48	17.80	108	82.5
9929 -48	Inc. 7929-48VY, (R576-89-18H18)	3304	9.31	17.67	158	81.5
9929 -56	Inc. 7929-56VY, (R576-89-18H18)	4070	11.24	18.10	156	83.7

TEST 6300. RHIZOMANIA EVALUATION OF MULTIGERM PROGENY LINES, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	RJAP %
Progeny Lines (cont.)						
9929 -62	Inc. 7929-62, (R576-89-18H18)	5054	14.48	17.47	124	83.6
9930 -17	Inc. 7930-17VY, (R578H18)	5476	16.04	17.13	167	83.8
9930 -32	Inc. 7930-32, (R678H5)	1756	5.17	16.90	144	83.3
9930 -35	Inc. 7930-35, (R678H5)	6131	16.82	18.23	167	81.4
9927 - 4	Inc. 7927-4VY, (5921H18)	9633	29.79	16.20	179	85.4
9927 -17	Inc. 7927-17VY, (5921H18)	6102	18.65	16.33	152	82.9
9928 -34	Inc. 7928-34, (6921H25)	6932	20.50	16.97	173	84.7
9928 -107	Inc. 7928-107, (Y671H15)	7979	23.17	17.27	161	82.6
Retest of Progeny Lines						
8927- 29	Inc. 6927- 29(A,aa),(5921H18)	7689	20.96	18.40	155	80.8
8929-112	Inc. 6929-112(A,aa),(4918aa x R76-89-18)	5757	16.39	17.57	138	81.5
8929-114	Inc. 6929-114(A,aa),(4918aa x R76-89-18)	5754	16.29	17.60	155	84.7
8930- 19	Inc. 6930- 19(A,aa),(R578H16)	7703	22.64	17.03	164	84.5
Mean		6615.2	18.96	17.46	157.9	83.2
LSD (.05)		2248.0	6.58	0.97	21.4	4.3
C.V. (%)		20.8	21.25	3.41	8.3	3.2
F value		8.1**	7.81**	4.99**	4.1**	2.0*

NOTES: See test 2100 for performance under nondiseased conditions and tests 3000 and 6900 for performance in testcross hybrids. Also see tests B300 and B600 for performance in Imperial Valley. Test 6300 was grown under severe rhizomania conditions and was highly variable. There was a moderate incidence of *Sclerotium rolfsii*.

TEST 6500. PERFORMANCE OF LINES UNDER RHIZOMANIA, SALINAS, CA., 2000

48 entries x 8 reps., RCB(E); 3 subtests, 16 x 8, RCB(E)
1-row plots, 22 ft. long

Planted: May 1, 2000
Harvested: November 8, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Bolting %
6500-1: Multigerm, O.P. Lines							
KW6770	Susc. check, 1997	5736	16.13	17.65	152	86.7	0.0
Alpine	Spreckels, 3-2-00	9115	26.23	17.46	147	86.6	0.0
99-EL-02/04	98-EL02,04 (smooth root x C80*Rz*)	8630	25.92	16.61	166	85.2	0.0
US H11	1999 production	5444	17.56	15.34	176	85.1	0.0
99-C46/2	Inc. U86-46/2, (C46/2) (*rzrz*)	7045	21.29	16.65	172	83.0	0.0
R978	RZM-ER-% R778,%, (C78)	9509	27.37	17.46	160	83.1	0.0
R980	RZM-ER-% R780/2, R780-45, (C80)	9294	27.06	17.40	167	83.9	0.0
R639	RZM R539, (C39R)	7859	23.24	17.09	141	83.5	0.0
Y969(Iso)	RZM-ER-% Y769, (C69)	9708	27.64	17.60	159	83.5	0.0
99-C31/6	Inc. F86-31/6, (C31/6) (*rzrz*)	6454	19.99	16.02	157	84.4	0.0
R881	RZM R776,R781,R781-43, (C82)	9211	26.94	17.13	159	85.2	0.0
R882	Inc. R781, R776,R781-43, (C82)	9900	29.74	16.66	160	85.9	0.0
99-C37	Inc. U86-37, (C37) (*rzrz*)	5769	17.44	16.55	178	83.4	0.0
R776-89-5NB	Inc. R576-89-5NB, (C76-89-5)	6727	18.83	17.98	158	82.6	0.0
R976-89-18	Inc. R576-89-18, (C76-89-18)	6220	18.18	17.16	140	84.6	0.0
R970	RZM-ER-% R770	10093	29.04	17.42	164	84.8	0.0
Mean		7919.6	23.29	17.01	159.8	84.5	-.-
LSD (.05)		1497.7	4.41	0.60	14.4	1.9	-.-
C.V. (%)		19.1	19.12	3.58	9.1	2.4	-.-
F value		9.9**	8.94**	9.83**	4.7**	3.3**	-.-

TEST 6500. PERFORMANCE OF LINES UNDER RHIZOMANIA, SALINAS, CA., 2000
48 entries x 8 reps., RCB(E). ANOVA across tests to compare means.

	Sugar Lbs	Beets Tons	Sucrose %	Beets/100' No.	RJAP %	Bolting %
Mean	8997.7	26.38	17.08	163.3	84.0	0.2
LSD (.05)	1362.5	3.98	0.61	16.4	2.0	0.9
C.V. (%)	15.4	15.30	3.64	10.2	2.4	426.2
F value	11.0**	11.09**	7.33**	2.9**	3.4**	11.2**

TEST 6500. PERFORMANCE OF LINES UNDER RHIZOMANIA, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP	Bolting
		Lbs	Tons	%	No.	%	%
6500-2: Multigerm lines with *Bvm* germplasm							
Beta 4776R	4776.9002 (4776RFA2), 9-8-99	11975	33.99	17.61	179	86.5	0.0
R926	RZM R826 (C26)	9192	27.78	16.56	169	82.7	0.0
R927	RZM R827 (C27)	9636	27.97	17.24	175	84.9	0.0
Y967	RZM-ER-% Y767(Iso), (C67)	10537	30.22	17.46	177	83.5	0.0
Y971	RZM-ER-% Y771(Iso)	10112	29.88	16.92	177	83.5	0.0
Y975	RZM Y875	11654	34.42	16.92	177	83.9	0.0
R943	RZM-ER-% R643	11755	34.66	16.98	158	83.9	0.0
R940	RZM-ER-% R740 (C79-#)	11685	35.56	16.45	175	84.3	0.0
R936	RZM-ER-% R736 (C79-8,R22)	9784	30.69	15.97	175	83.7	0.0
P907	RZM-PMR P807,P808,F_2[C78x(Y71xPMR)]	10551	31.52	16.76	174	83.0	0.0
P909	RZM-PMR P809,P810,F_2[C78x(C79xPMR)]	8928	26.17	17.16	164	83.9	3.6
P915	RZM-PMR P815,P816,F_2(C78xP603,P604)	8018	23.63	16.94	170	83.1	6.3
CR909-1	RZM R709-1 (CR09-1)	7396	21.67	16.95	160	79.7	0.0
CR910	RZM R710,R709-9,R710-10,R710-14	8890	26.92	16.51	160	83.4	0.0
CR911(C)	CR811(C)aa x A, (CR09,10)	9709	29.42	16.52	166	82.8	0.0
Rifle	Spreckels, 1999	10751	29.78	18.02	174	83.9	0.0
Mean		10035.8	29.64	16.94	170.6	83.6	0.6
LSD (.05)		966.2	2.77	0.56	10.3	2.3	1.5
C.V. (%)		9.7	9.44	3.35	6.1	2.7	242.7
F value		15.5**	15.82**	6.18**	3.7**	2.9**	11.0**

NOTES: See tests 2200 and 2500 for performance without disease. See test 200 for nonbolting tendency and 4300 for reaction to *Erwinia*.

Test 6500 was grown under moderately severe rhizomania conditions. The entries in 6500-1 and 6500-2 are primarily MM,O.P., breeding lines from the Salinas program. Commercial hybrids were used as checks. In test 6500-2, lines listed from C26 thru P915 have a wild beet (*Bvm*) component. CR09-1 = CR909-1 and is an increase of an S_1 progeny.

TEST 6500. PERFORMANCE OF LINES UNDER RHIZOMANIA, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP	Bolting
		Lbs	Tons	%	No.	%	%
6500-3: Multigerm, S^f,A:aa popns & lines							
Beta 4430R	L4430.8052, rec'd 3-10-99	8604	22.58	18.95	154	86.7	0.0
Z925	RZM-ER-% Z725(C), (%S)	8463	23.67	17.91	162	83.0	0.0
9924	RZM 8924aa x A, (VY)	10472	29.77	17.61	163	85.1	0.0
9926	8926aa x A, (RZM-*Bvm*)	9877	29.37	16.84	158	84.2	0.0
9931	RZM 8931aa x A, (base popn)	10258	30.54	16.89	156	84.1	0.0
9932	RZM 8932aa x A, (CTR,%S)	8865	25.73	17.27	153	84.8	0.0
9933	8933aa x A, (Root aphid, *Rz*)	10550	31.09	17.01	160	84.3	0.0
9934	RZM 8934(C), (VT,*Rz*,*Bvm*)	10020	29.43	17.00	151	84.1	0.0
9941	941(C)aa x A, (VY-*Rz*)	9452	27.09	17.46	157	85.5	0.0
8935(Sp)	Inc. R776-89-5H13(Aa)	7760	22.57	17.17	152	83.5	0.0
8936	RZM R776-89-5H31(Aa)	8575	24.54	17.52	153	82.5	0.0
8937	RZM R776-89-5H11(Aa)	8310	23.92	17.40	157	82.8	0.0
8939	RZM Y769H31(Aa)	9104	26.49	17.17	166	85.0	0.0
8913-70	RZM-ER-% 6913-70, (C913-70)	6842	20.01	17.06	165	82.3	0.0
9836	RZM 8836, (mm,T-O,VY)	7750	23.41	16.56	166	82.1	0.0
9835	8835mmaa x A, (mm,T-O,CT)	9701	29.31	16.58	178	85.0	0.0
Mean		9037.7	26.22	17.28	159.5	84.1	-.-
LSD (.05)		1372.6	3.84	0.62	15.3	1.8	-.-
C.V. (%)		15.3	14.79	3.64	9.7	2.2	-.-
F value		4.9**	6.16**	6.72**	1.7*	3.8**	-.-

NOTES: Test 6500-3 primarily contains MM,S^f,Aa populations and lines. 9931 = base population-931 undergoing improvement for all traits and was used as a major component to develop most of the other populations: CR910 and CR911 have resistance to *Cercospora* introgressed; Z925 has high %S germplasm from Polish sources; 9926 has resistance to rhizomania from C51 (*Bvm*); virus yellows resistance was emphasized for 9924; CTR for 9932; root aphid resistance for 9933; etc. Populations 9836 and 9835 are monogerm.

TEST 2800. EVALUATION OF MONOGERM LINES & POPULATIONS, SALINAS, CA., 2000

24 entries x 4 reps., sequential
1-row plots, 22 ft. long

Planted: March 22, 2000
Harvested: September 28, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Root Rot %	RJAP %
Checks							
99-790-15	Inc. F92-790-15, (C790-15)	16852	51.45	16.38	167	0.7	83.5
99-790-68	Inc. U88-790-68, (C790-68)	14431	43.13	16.74	169	0.7	83.4
Monogerm lines							
8911-4-10M	RZM-ER-% 6911-4-10	15601	45.65	17.09	162	0.0	79.3
9869-6	RZM 7869-6	16940	52.40	16.16	152	0.0	83.1
9867-1	RZM 7867-1 (C867-1)	12589	38.60	16.29	152	0.0	81.6
9829-3	RZM 8829-3-#(C), (C829-3)	14439	44.14	16.32	159	0.0	80.2
9831-3	RZM 8831-3, (C831-3)	14600	45.05	16.21	143	0.0	83.1
9831-4	RZM 8831-4, (C831-4)	16857	50.69	16.63	151	0.0	79.5
9833-5 T-O	RZM, T-O 8833-5-#(C), (C833-5)	13068	38.19	17.11	147	0.0	80.6
9833-5	RZM 8833-5, (C833-5)	14484	41.92	17.29	147	0.0	81.8
9833-12	RZM 8833-12, (C833-12)	13307	42.33	15.74	147	0.0	83.6
N965M	RZM N865(C) galls,…	14474	45.85	15.79	143	0.0	82.2
Monogerm populations							
9832	RZM 8932H38mmaa x 8932	18868	57.64	16.38	153	0.0	83.8
9835	8835mmaa x A	17588	52.71	16.71	164	0.0	82.9
9838	8838mmaa x A	16630	51.40	16.19	161	0.0	83.1
9840	840mmaa(C) x mm, T-O, CTR	17724	54.12	16.42	167	0.0	82.3
9808	RZM,T-O 8808-#(C)	14867	46.15	16.09	161	0.0	83.6
9818M	RZM-ER-% 7818,7848	16079	48.78	16.51	151	0.0	81.9
9833	RZM 8833	13980	43.94	15.94	164	0.0	81.9
9836	RZM 8836	16204	49.68	16.34	167	0.0	82.2

TEST 2800. EVALUATION OF MONOGERM LINES & POPULATIONS, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Root Rot %	RJAP %
Monogerm populations (cont.)							
9835 T-O	RZM, T-O 8835-#(C)	13937	44.04	15.80	160	0.7	81.6
9869	RZM-ER-% 7869NB	17193	53.21	16.19	162	0.0	83.0
Hybrid checks							
Beta 4776R	Betaseed, 1999	21595	62.38	17.31	168	0.0	84.6
9931H5	C833-5aa x RZM 8931	20617	59.56	17.31	161	0.0	82.8
Mean		15955.2	48.46	16.46	157.5	0.1	82.3
LSD (.05)		2154.0	6.61	0.58	11.6	0.7	1.4
C.V. (%)		9.6	9.67	2.50	5.2	562.9	1.2
F value		8.9**	7.24**	5.49**	4.2**	0.9NS	7.5**

NOTES: C790-15CMS used as tester = C790-68CMS x C790-15. Monogerm version of 8911-4-10 released as C911-4-10. N965M segregates for resistance to SBCN from *B.procumbens*. Popn-835 (9835) is the base monogerm, S^f, Aa, *Rz* population for population improvement and is composed of monogerm, O-type lines developed at Salinas. Population 9832 has an infusion of CTR MM germplasm. 9838 & 9836 have added VYR germplasm. 9840 is from popn-835 et al. crossed to mm, O-type, CTR lines, e.g., C562, C546, C718, C762-17. 9808 & 9818 have resistance to rhizomania from C51 (R22) in a C790 background. 9833 is a predecessor to popn-835 and source of C833-5. 9869 = improved C869 mm, *Rz* population.

Test 2800 is an evaluation of monogerm lines and populations under nondiseased conditions. See test 6200 for evaluation under rhizomania.

TEST 6200. EVALUATION OF MONOGERM LINES AND POPULATIONS UNDER RHIZOMANIA, SALINAS, CA., 2000

24 entries x 4 reps., RCB(e)
1-row plots, 22 ft. long

Planted: May 1, 2000
Harvested: November 9, 2000

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP
		Lbs	Tons	%	No.	%
Checks						
99-790-15	Inc. F92-790-15, (C790-15)	5756	17.28	16.73	189	85.0
99-790-68	Inc. U88-790-68, (C790-68)	4154	12.22	17.17	175	84.9
Monogerm lines						
8911-4-10M	RZM-ER-% 6911-4-10	4905	14.06	17.58	162	80.1
9869-6	RZM 7869-6	6821	20.20	16.95	169	84.8
9867-1	RZM 7867-1	4711	13.37	17.80	170	82.6
9829-3	RZM 8829-3-#(C), (C829-3)	2954	9.04	16.55	175	80.7
9831-3	RZM 8831-3, (C831-3)	7255	22.25	16.33	158	84.0
9831-4	RZM 8831-4, (C831-4)	7311	21.58	16.95	186	79.7
9833-5 T-O	RZM, T-O 8833-5-#(C), (C833-5)	4397	12.43	17.67	162	80.3
9833-5	RZM 8833-5, (C833-5)	5236	14.61	17.95	160	82.8
9833-12	RZM 8833-12, (C833-12)	4104	12.60	16.30	160	80.2
N965M	RZM N865(C) galls,…	8386	25.02	16.75	168	85.3
Monogerm populations						
9832	RZM 8932H38mmaa x 8932	8165	23.77	17.15	158	84.4
9835	8835mmaa x A	9192	27.02	16.98	181	85.5
9838	8838mmaa x A	7907	23.39	16.98	178	85.6
9840	840mmaa(C) x mm, T-O, CTR	8345	23.96	17.45	178	83.7
9808	RZM,T-O 8808-#(C)	3167	9.61	16.52	168	84.0
9818M	RZM-ER-% 7818,7848	8221	24.54	16.65	161	84.9
9833	RZM 8833	4737	14.13	16.75	178	82.5
9836	RZM 8836	7910	23.68	16.73	181	81.8

TEST 6200. EVALUATION OF MONOGERM LINES AND POPULATIONS UNDER RHIZOMANIA, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %
Monogerm populations (cont.)						
9835 T-O	RZM, T-O 8835-#(C)	6774	20.45	16.63	178	82.9
9869	RZM-ER-% 7869NB	6681	19.48	17.15	187	85.3
Hybrid checks						
Beta 4776R	Betaseed, 1999	10303	30.17	17.05	197	84.3
9931H5	8833-5aa x RZM 8931	12016	33.80	17.77	176	85.1
Mean		6642.0	19.53	17.02	173.3	83.4
LSD (.05)		1733.2	5.18	0.59	12.6	2.5
C.V. (%)		26.2	26.62	3.45	7.3	3.0
F value		6.9**	6.42**	2.58**	2.9**	2.5**

NOTES: C790-15CMS used as tester = C790-68CMS x C790-15. Monogerm version of 8911-4-10 released as C911-4-10. N965M segregates for resistance to SBCN from *B.procumbens*. Popn-835 (9835) is the base monogerm, S^f, Aa, *Rz* population for population improvement and is composed of monogerm, O-type lines developed at Salinas. Population 9832 has an infusion of CTR MM germplasm. 9838 & 9836 have added VYR germplasm. 9840 is from popn-835 et al. crossed to mm, O-type, CTR lines, e.g., C562, C546, C718, C762-17. 9808 & 9818 have resistance to rhizomania from C51 (R22) in a C790 background. 9833 is a predecessor to popn-835 and source of C833-5. 9869 = improved C869 mm, *Rz* population.

Test 6200 evaluates monogerm lines and populations under rhizomania conditions. See test 2800 for evaluation under nondiseased conditions. Test 6200 was grown under severe rhizomania conditions and was highly variable. As previously observed, partially inbred lines do not perform well when grown under diseased conditions.

TEST 2300-2600. PERFORMANCE OF HYBRIDS WITHOUT BChV, SALINAS, CA., 2000

24 entries x 16 reps., RCB
1-row plots, 22 ft. long

Planted: March 23, 2000
Harvested: October 2-4, 2000

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP	Powdery Mildew
		Lbs	Tons	%	No.	%	%
Checks							
KW6770	susc. check, rec'd 1997	16838	44.74	18.83	157	85.0	4.4
R776-89-5H50	C790-15CMS x C576-89-5	17895	53.01	16.88	157	84.0	3.7
California Commercial Hybrids							
Beta 4776R	L4776.9002, rec'd 9-8-99	18713	53.51	17.53	163	85.8	3.4
Beta 4430R	L4430.9041, rec'd 9-8-99	19337	56.31	17.17	165	85.1	3.0
Beta 4035R	rec'd 7-10-97	18287	53.31	17.14	161	84.2	5.4
Rifle	rec'd 2-8-99	17841	50.84	17.54	159	83.7	4.4
Phoenix	Spreckels, 3-2-00	18188	53.54	16.99	163	84.7	4.0
Alpine	Spreckels, 3-2-00	17901	53.59	16.70	161	83.9	6.3
Checks							
US H11	1999 production, 9-14-99	16685	50.80	16.45	159	83.8	8.1
9941H50	C790-15CMS x 941(C)	17834	53.65	16.63	158	83.8	4.1
Colorado Commercial Hybrids							
Monohikari	rec'd 3-1-00	17534	49.30	17.80	159	85.3	6.1
Beta 6045	" "	17938	47.79	18.77	164	85.9	4.3
HM9155	" "	17034	50.61	16.84	168	83.3	4.8
HM1639R	" "	16884	50.05	16.87	156	83.8	3.9
Ranger	" "	16791	48.80	17.21	162	83.1	4.1
ACH205	" "	17980	50.69	17.76	165	83.3	4.3
Experimental Hybrids							
Y969H3	C562HO x Y869	17594	52.48	16.77	160	83.7	5.1
Y969H4	C831-3aa x Y869	16958	50.48	16.79	141	83.7	3.4

TEST 2300-2600. PERFORMANCE OF HYBRIDS WITHOUT BChV, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP	Powdery Mildew
		Lbs	Tons	%	No.	%	%
Experimental Hybrids (cont.)							
Y969H5	C833-5aa x Y869	17890	52.90	16.89	150	82.7	3.3
Y969H6	C833-5H50 x Y869	17933	54.39	16.48	156	83.2	3.3
Y969H27	C831-4HO x Y869	18455	56.38	16.36	161	82.7	3.8
Y969H50(Sp)	C790-15CMS x Y869	18011	54.07	16.66	159	84.7	3.5
Y969H35	8835mmaa x Y869	18058	54.34	16.61	162	83.9	4.7
Y969H38	8838mmaa x Y869	17770	53.94	16.49	152	83.7	4.3
Mean		17764.5	52.06	17.09	159.0	84.0	4.4
LSD (.05)		883.9	2.36	0.38	5.5	1.3	0.7
C.V. (%)		7.2	6.52	3.21	4.9	2.2	23.3
F value		4.2**	10.33**	23.19**	8.1**	3.6**	20.3**

NOTES: Tests 2300 and 2600 were identical companion tests planned to evaluate the relative effects of BChV. However, due to problems raising aphids, test 2300 was not inoculated. Instead of two 24V x 8R inoculated vs. noninoculated companion tests, the tests were analyzed as one 24V x 16R test.

Because BChV has been identified in both the Eastern Shore and the West, hybrids were chosen from these areas. With Steve Godby's help, a set of six commercial hybrids were chosen from the Colorado-Nebraska area and an equal number were used to represent California commercial hybrids. Because BChV inoculation was not done, these tests were grown under nearly disease free conditions at Salinas. Probably a moderate incidence of BWYV infection did occur naturally. These trials followed strawberries in soil that had been fumigated with methyl bromide/chloropricrin and no soilborne problems were detected. Powdery mildew was controlled until very late in the season.

KW6770 was included as a high %S, BChV susceptible check. The Salinas experimental hybrids were ones that likely would have had partial resistance to BChV.

Powdery mildew score is the mean of two ratings by two individuals.

TEST 2400 & 2700. PERFORMANCE OF EXPERIMENTAL HYBRIDS WITHOUT/UNDER BChV, SALINAS, CA., 2000

12 entries x 16 reps., RCB
1-row plots, 22 ft. long

Planted: March 23, 2000
Harvested: September 28, 2000
October 3, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Root Rot %	RJAP %
Checks							
KW6770	susc. check, 1997	17651	46.82	18.86	152	0.8	84.1
Beta 4776R	L4776.9002, 9-8-99	19138	55.82	17.13	164	0.3	83.6
9931H5	C833-5aa x RZM 8931	18999	56.14	16.94	157	0.0	83.0
9931H27	C831-4HO x RZM 8931	19955	59.73	16.71	159	0.0	83.1
Hybrids with Sources of VYR							
R776-89-5H50	C790-15CMS x C76-89-5	18365	54.30	16.92	153	0.0	83.0
8913-70H50	C790-15CMS x C913-70	19232	57.37	16.77	154	0.0	83.6
9931H50	C790-15CMS x RZM 8931	19637	58.35	16.84	159	0.2	83.0
Y969H50(Iso)	C790-15CMS x RZM-ER-% Y769 (C69)	19113	56.99	16.77	158	0.0	83.7
Hybrids with Combined Sources							
8935H50	C790-15CMS x R776-89-5H13	19265	58.00	16.62	164	0.0	83.8
8936H50	C790-15CMS x RZM R776-89-5H31	19033	56.86	16.73	156	0.0	83.3
8939H50	C790-15CMS x RZM Y769H31	19369	57.75	16.76	156	0.0	83.2
9941H50	C790-15CMS x 941(C)	18845	57.22	16.48	159	0.0	83.5
Mean		19050.3	56.28	16.96	157.6	0.1	83.4
LSD (.05)		813.0	2.27	0.35	5.9	0.6	1.0
C.V. (%)		6.1	5.77	2.93	5.4	779.7	1.7
F value		4.1**	16.27**	25.00**	3.6**	1.3NS	1.1NS

NOTES: See notes for tests 2300 & 2600. That is, because we failed to make BChV inoculations, tests 2400 and 2700 were combined into a single test with 12V x 16R.

Lines C76-89-5, C913-70, population-931, and line C69 have been identified as having resistance to VY. Combinations of these lines were used as F_1 pollinators: R776-89-5H13 = F_1 (C913-70aa x C76-89-5); R776-89-5H31 = F_1 (popn-931aa x C76-89-5); Y769H31 = F_1 (popn-931aa x C69). Population941 = recombination of the above F_1's into an F_2 population.

TEST 2900. EVALUATION OF TESTCROSS HYBRIDS, SALINAS, CA., 2000

48 entries x 8 reps., RCB(E)
1-row plots, 22 ft. long

Planted: March 22, 2000
Harvested: September 27, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Root Rot %	RJAP %
2900-1: Testcrossed with MM breeding lines							
Beta 4430R	4430.9041, 9-8-99	20280	58.70	17.29	168	0.0	85.1
Alpine	X612401, 9-10-99	18277	53.32	17.13	155	0.0	85.3
Y969H50 (Iso)	C790-15CMS x RZM-ER-% Y769	17333	51.29	16.90	159	0.0	82.9
R978H50	C790-15CMS x RZM-ER-% R778	18130	53.56	16.91	161	0.0	83.2
R980H50	C790-15CMS x RZM-ER-% R780/2,…	18615	54.83	16.96	160	0.0	84.1
R970H50	C790-15CMS x RZM-ER-% R770	17293	50.49	17.13	162	0.0	83.4
R776-89-5H50	C790-15CMS x R576-89-5	16970	50.64	16.73	157	0.0	82.4
R976-89-18H50	C790-15CMS x R576-89-18	18602	55.45	16.77	161	0.0	84.6
R976-89H50	C790-15CMS x R76-89-5/18	18509	54.62	16.94	157	0.0	84.3
9941H50	C790-15CMS x RZM 941(C)	17977	54.00	16.65	165	0.0	83.2
9931H50	C790-15CMS x RZM 8931	17105	51.46	16.61	157	0.0	84.1
9924H50	C790-15CMS x RZM 8924	16360	49.13	16.65	166	0.0	83.9
9932H50	C790-15CMS x RZM 8932	17354	51.95	16.69	158	0.0	83.7
9933H50	C790-15CMS x 8933	17880	52.25	17.13	162	0.0	84.7
CR909-1H50	C790-15CMS x RZM R709-1	17752	52.91	16.79	152	0.0	82.2
CR911H50	C790-15CMS x CR811(C)	17120	52.35	16.35	160	0.0	83.3
Mean		17847.8	52.94	16.85	160.0	-.-	83.8
LSD (.05)		1499.3	4.08	0.48	7.7	-.-	1.6
C.V. (%)		8.5	7.78	2.87	4.8	-.-	1.9
F value		3.0**	2.52**	2.01*	2.2*	-.-	2.6**

TEST 2900. EVALUATION OF TESTCROSS HYBRIDS, SALINAS, CA., 2000
48 entries x 8 reps., RCB(E). ANOVA to compare means across sets.

		Sugar Lbs	Beets Tons	Sucrose %	Beets/100' No.	Root Rot %	RJAP %
Mean		17486.8	52.17	16.76	158.5	0.04	83.6
LSD (.05)		1553.8	4.46	0.53	10.4	0.52	1.6
C.V. (%)		9.0	8.68	3.18	6.6	1198.90	1.9
F value		2.7**	2.23**	2.10**	3.1**	1.47*	2.5**

TEST 2900. EVALUATION OF TESTCROSS HYBRIDS, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
2900-2: Testcrossed with lines with *Bvm* germplasm							
Beta 4776R	4776.9002, 9-8-99	19133	55.17	17.33	169	0.0	83.9
Z925H50	C790-15CMS x RZM-ER-% Z725(C)	17280	51.85	16.69	161	0.0	82.7
R940H50	C790-15CMS x RZM-ER-% R740	16324	49.38	16.55	149	0.0	82.9
R954H50	C790-15CMS x RZM-ER-% x R746,R754	17434	52.35	16.65	152	0.0	83.1
R936H50	C790-15CMS x RZM-ER-% R736	16955	51.65	16.41	155	0.0	83.4
R943H50	C790-15CMS x RZM-ER-% R643	16473	48.33	17.05	141	0.0	83.4
P909H50	C790-15CMS x PMR-RZM P809,P810	16817	51.24	16.46	156	1.4	84.1
P911H50	C790-15CMS x PMR-RZM P811	18427	56.03	16.44	160	0.7	85.2
P912H50	C790-15CMS x PMR-RZM P812	17072	51.19	16.70	157	0.0	84.2
Y967H50	C790-15CMS x RZM-ER-% Y767	16059	47.57	16.91	156	0.0	84.9
Y971H50	C790-15CMS x RZM-ER-% Y771	16186	49.14	16.49	159	0.0	83.4
9934H50	C790-15CMS x RZM 8934(C)	17325	52.15	16.61	162	0.0	83.7
9926H50	C790-15CMS x RZM 8926	18295	54.57	16.77	163	0.0	83.3
Y975H50	C790-15CMS x RZM Y875	17295	52.91	16.34	161	0.0	83.6
Y975H5	C833-5aa x RZM Y875	16490	49.10	16.77	141	0.0	82.4
Y975H6	C833-5H50 x RZM Y875	17130	51.70	16.52	157	0.0	82.0
Mean		17168.4	51.52	16.67	156.3	0.13	83.5
LSD (.05)		1458.7	4.36	0.56	8.2	0.89	1.8
C.V. (%)		8.6	8.54	3.40	5.3	674.50	2.2
F value		2.7**	2.43**	1.66NS	6.5**	1.47NS	1.8*

NOTES: Also see tests 100 & 6800 at Salinas and B100 at Brawley.

2900-2: C790-15CMS (C790-68CMS x C790-15) was used as a common female tester and is susceptible to rhizomania. C790-68 was selected from cycle 3 and C790-15 from cycle 5 of S_1 progeny recurrent selection within popn-790. Y769 ≈ C69. R778 ≈ C78. R780/2 ≈ C80. R576-89-5 = C76-89-5. R576-89-18 = C76-18. R76-89-5/18 is an F_1 hybrid and line mix between C76-89-5 & C76-89-18. R709-1 ≈ CR909-1 = CR09-1 released in 2000. CR811(C) = CR11. C833-5H50 = C790-15CMS x C833-5. R736≈ C79-8. Y767 ≈ C67 with C51(R22) germplasm.

TEST 2900. EVALUATION OF TESTCROSS HYBRIDS, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
2900-3: Topcrosses							
Phoenix	Spreckels, 2000	19044	55.73	17.09	171	0.0	84.2
Y969H50(Sp)	C790-15CMS x Y869	16593	50.74	16.39	164	0.0	84.2
Y969H5	C833-5aa x Y869	17450	51.14	17.04	155	0.0	83.2
Y969H6	C833-5H50 x Y869	18214	54.47	16.67	159	0.0	83.1
Y969H3	97-C562HO x Y869	16329	49.23	16.59	163	0.0	83.6
Y969H45	C867-1HO x Y869	17417	51.95	16.77	165	0.0	83.2
Y969H46	7869-6HO x Y869	17256	52.35	16.41	165	0.0	85.1
Y969H12	C833-12aa x Y869	19165	57.59	16.64	152	0.0	84.8
Y969H4	C831-3aa x Y869	17597	52.05	16.91	140	0.0	83.7
Y969H27	C831-4Hox Y869	17270	53.06	16.26	162	0.0	81.7
Y969H29	C829-3aa x Y869	16127	48.55	16.61	153	0.0	83.0
Y976-89H5	C833-5aa x R76-89-5/18	18215	52.65	17.30	159	0.0	83.7
Y976-89H6	C833-5H50 x R76-89-5/18	17835	52.10	17.14	166	0.0	83.3
9931H5	C833-5aa x RZM 8931	16965	51.19	16.61	155	0.0	81.5
9931H6	C833-5H50 x RZM 8931	16440	49.57	16.66	158	0.0	83.5
9941H6	C833-5H50 x 941(C)	17191	50.34	17.09	162	0.0	83.2
Mean		17444.3	52.05	16.76	159.3	-.-	83.4
LSD (.05)		1746.6	5.18	0.54	8.3	-.-	1.5
C.V. (%)		10.1	10.04	3.23	5.2	-.-	1.8
F value		2.1*	1.64NS	2.48**	6.1**	-.-	3.3**

NOTES for 2900-3:
Y869 ≈ C69. 8931 = base MM,S^f,Aa,Rz population.

TEST 3000. PERFORMANCE OF HYBRIDS WITH S_1 PROGENY POLLINATORS, SALINAS, CA., 2000

48 entries x 8 reps., RCB(E)
1-row plots, 22 ft. long

Planted: March 22, 2000
Harvested: September 26, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
3000-1: Checks and retests from 1999							
Alpine	Spreckels, 3-2-00	18915	55.68	16.99	161	0.0	83.5
Beta 4430R	4430.9041, 9-8-99	20767	59.76	17.38	168	0.0	84.7
9918-21H50	C790-15CMS x RZM 8918-21	18874	57.84	16.33	157	0.0	84.9
8925-19H50	C790-15CMS x 6925-19	18560	56.94	16.29	161	0.0	83.1
Z825-6H50	C790-15CMS x Z625-6	19539	55.53	17.60	157	0.0	83.7
Z825-9H50	C790-15CMS x Z625-9	17690	49.93	17.73	153	0.7	82.8
8929-112H50	C790-15CMS x 6929-112	18974	54.77	17.33	155	0.0	83.8
8929-114H50	C790-15CMS x 6929-114	18710	55.39	16.90	153	0.0	83.6
8929-115H50	C790-15CMS x 6929-115	17702	51.45	17.21	153	0.0	83.3
8930-19H50	C790-15CMS x 6930-19	18848	55.95	16.88	153	0.0	84.4
8927-29H50	C790-15CMS x 6927-29	17229	50.27	17.14	151	0.0	82.6
8911-4-10H50	C790-15CMS x 6911-4-10	17742	50.74	17.48	155	0.4	82.2
9941H50	C790-15CMS x 941(C)	18038	53.66	16.84	158	0.0	83.8
9941H6	C833-5H50 x 941(C)	17870	52.20	17.13	156	0.0	82.2
R976-89H5	C833-5aa x R76-89-5/18	17732	51.24	17.30	151	0.0	82.9
R976-89H6	C833-5H50 x R76-89-5/18	18591	54.26	17.13	159	0.0	83.4
Mean		18486.3	54.10	17.10	156.3	0.7	83.4
LSD (.05)		1106.3	3.11	0.44	7.2	0.6	1.3
C.V. (%)		6.1	5.80	2.60	4.6	849.2	1.6
F value		5.0**	6.85*	6.48**	3.0**	0.9NS	2.9**

TEST 3000. PERFORMANCE OF HYBRIDS WITH S_1 PROGENY POLLINATORS, SALINAS, CA., 2000
48 entries x 8 reps, RCB(E). ANOVA across tests to compare means.

Mean	18287.7	53.73	17.03	156.8	0.1	83.5
LSD (.05)	1180.0	3.45	0.48	8.7	0.6	1.3
C.V. (%)	6.6	6.52	2.83	5.6	680.0	1.6
F value	3.2**	4.34**	4.31**	2.0**	1.0NS	2.3**

TEST 3000. PERFORMANCE OF HYBRIDS WITH S_1 PROGENY POLLINATORS, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
3000-2: Hybrids with popns-931 & -924, et al.							
Beta 4776R	Betaseed, 3-2-00	19118	54.77	17.45	169	0.0	84.9
9931H50	C790-15CMS x RZM 8931	17637	53.46	16.51	156	0.0	83.2
Z925H50	C790-15CMS x RZM-ER-% Z725(C)	18058	52.81	17.10	157	0.0	84.1
9931-18H50	C790-15CMS x 7931-18	17686	52.15	16.96	160	0.0	82.3
9931-24H50	C790-15CMS x 7931-24	17351	50.79	17.09	159	0.0	82.1
9931-29H50	C790-15CMS x 7931-29	18726	56.64	16.54	154	0.0	83.2
9924H50	C790-15CMS x 8924	18162	53.91	16.84	166	0.0	83.3
9924-2H50	C790-15CMS x 7924-2	18232	51.45	17.71	157	0.0	83.6
9924-6H50	C790-15CMS x 7924-6	17334	50.14	17.29	167	0.0	82.4
9924-10H50	C790-15CMS x 7924-10	17276	50.94	16.96	159	0.0	83.1
9924-74H50	C790-15CMS x 7924-74%	18061	53.29	16.99	155	0.0	84.2
9931H5	C833-5aa x RZM 8931	18280	53.41	17.11	157	0.0	83.3
9924-78H50	C790-15CMS x 7924-78	18347	52.65	17.42	156	0.0	83.6
9924-114H50	C790-15CMS x 7924-114VY	16753	49.58	16.91	156	0.0	82.6
9926H50	C790-15CMS x 8926	18523	55.22	16.79	162	0.0	82.8
9927-4H50	C790-15CMS x 7927-4VY	19265	57.69	16.71	159	0.0	84.2
Mean		18050.6	53.06	17.02	159.4	-.-	83.3
LSD (.05)		1062.2	2.92	0.52	7.5	-.-	1.3
C.V. (%)		5.9	5.56	3.09	4.8	-.-	1.6
F value		3.3**	4.71**	3.10**	2.9**	-.-	2.7**

Notes for 3000-2: From improved MM,S^f,Aa,*Rz* populations, individual plants were selfed in the greenhouse under paper bags in 1997. In 1998, S_1 progeny lines per se were evaluated under virus yellows, rhizomania, and bolting conditions. Based upon these S_1 tests, lines were selected and testcrossed to the common tester C790-15CMS. These experimental hybrids were evaluated in 2000 at Brawley and Salinas. From Brawley, see tests B300, and B600. From Salinas see tests 100, 200, 2100, 4400, 6300, and 6900.

TEST 3000. PERFORMANCE OF HYBRIDS WITH S_1 PROGENY POLLINATORS, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	RJAP
		Lbs	Tons	%	No.	%	%
3000-3: Hybrids with popns-929 & -930, et al.							
9927-17H50	C790-15CMS x 7927-17VY	19358	58.36	16.59	158	0.0	83.9
9928-34H50	C790-15CMS x 7928-34	18496	56.69	16.33	155	0.0	83.9
9928-107H50	C790-15CMS x 7928-107	17826	52.43	17.00	153	0.0	83.9
R976-89-18H50	C790-15CMS x R576-89-18	18558	55.28	16.80	152	0.4	83.6
9929-4H50	C790-15CMS x 7929-4VY	19147	56.34	17.00	151	0.0	83.3
9929-9H50	C790-15CMS x 7929-9VY	18764	55.40	16.94	151	0.0	83.7
9939-45H50	C790-15CMS x 7929-45	18876	55.54	17.01	153	0.0	84.5
9929-47H50	C790-15CMS x 7929-47VY	18162	53.84	16.88	156	0.0	84.2
9929-48H50	C790-15CMS x 7929-48VY	18060	51.60	17.50	157	0.0	83.5
9929-56H50	C790-15CMS x 7929-56VY	16723	49.33	16.98	159	0.4	83.4
9929-62H50	C790-15CMS x 7929-62VY	19059	57.90	16.49	155	0.0	83.1
R978H50	C790-15CMS x RZM-ER-% R778	17836	51.85	17.20	154	0.0	83.6
9930-17H50	C790-15CMS x 7930-17VY	17455	51.85	16.88	156	0.8	83.0
9930-32H50	C790-15CMS x 7930-32	18738	53.31	17.58	153	0.7	82.7
9930-35H50	C790-15CMS x 7930-35	18037	51.76	17.42	154	0.0	84.0
Phoenix	Spreckels, 3-2-00	18126	53.11	17.06	161	0.4	85.0
Mean		18326.2	54.04	16.98	154.9	0.2	73.7
LSD (.05)		1324.2	3.89	0.45	9.3	0.8	1.4
C.V. (%)		7.3	7.28	2.68	6.1	488.7	1.6
F value		2.1*	3.40**	4.55**	0.7NS	0.9NS	1.4NS

NOTES for 3000-1: Z625-9 & 6911-4-10 were released as CZ25-9 and C911-4-10mm in 2000. C833-5 was rereleased in 2000. C833-5H50 = C790-15CMS x C833-5. R76-89-5/18 is a mix and F_1 hybrid between C76-89-5 and C76-89-18. Progeny lines Z625-6 & -9 have ZZ germplasm from Polish accessions. 8918-21 & 8918-21 are S_1 lines from popn-931. 6929-112,-114, & -115 are S_1 lines from a population cross between popn-931 and C31 types. 6930-19 is an S_1 line from a popn cross between C931 and C78. 6927-29 has *Bvm* (C51) germplasm.

TEST 3100. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES, SALINAS, CA, 2000

72 entries x 4 reps., RCB(E)
1-row plots, 22 ft. long

Planted: March 22, 2000
Harvested: September 26, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Root Rot %	RJAP %
Checks							
Beta 4776R	Betaseed, 3-1-00	19258	55.43	17.38	169	0.0	83.8
Beta 4430R	4430.9041, 9-8-99	21300	61.67	17.25	168	0.0	86.2
Alpine	Spreckels, 3-2-00	19385	57.84	16.78	167	0.0	83.1
Phoenix	Spreckels, 3-2-00	18982	54.22	17.50	170	0.0	84.3
Y969H50	C790-15CMS x Y869	17614	54.52	16.17	156	0.0	84.0
S_1 progenies from line C829-3							
Y969H29-31	8829-3- 1aa x Y869	18390	56.43	16.30	147	0.0	83.0
-35	- 5aa x Y869	17348	52.00	16.67	150	0.0	82.2
-310	-10aa x Y869	17881	53.51	16.73	156	0.0	81.8
S_1 progenies from popn-835							
Y969H35	8835aa x Y869	18232	54.72	16.65	149	0.0	82.5
Y969H35 - 1	8835 - 1aa x Y869	17408	52.81	16.50	166	0.7	82.5
Y969H35 - 2	8835 - 2aa	18296	55.63	16.48	153	0.0	83.2
Y969H35 - 3	8835 - 3aa	17530	53.31	16.42	152	0.0	81.6
Y969H35 - 4	8835 - 4aa x Y869	16997	51.29	16.55	143	0.0	83.5
- 6	- 6aa	18403	56.84	16.20	158	0.0	83.3
- 7	- 7aa	16688	50.39	16.60	164	0.0	82.7
- 8	- 8aa	18500	57.44	16.13	140	0.0	81.1
Y969H35 - 9	8835 - 9aa x Y869	16995	50.59	16.83	150	0.0	83.9
-10	-10aa	18238	57.04	16.00	149	0.0	83.1
-11	-11aa	18448	54.32	17.00	157	0.0	81.6
-12	-12aa	17547	53.99	16.27	135	0.0	82.6

TEST 3100. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES, SALINAS, CA, 2000

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	RJAP
		Lbs	Tons	%	No.	%	%
S_1 progenies from popn-835							
Y969H35 -13	8835 -13aa x Y869	19371	57.44	16.85	168	0.0	83.5
-14	-14aa	15468	47.24	16.38	134	0.0	83.4
-16	-16aa	17889	53.41	16.73	159	0.0	85.0
-17	-17aa	18113	53.41	16.95	158	0.0	82.9
Y969H35 -18	8835 -18aa x Y869	18193	54.72	16.63	159	0.0	83.1
-22	-22aa	17798	53.51	16.63	153	0.0	83.1
-24	-24aa	18512	55.53	16.67	153	0.0	83.5
-25	-25aa	16631	51.40	16.20	160	0.0	84.6
Y969H35 -26	8835 -26aa x Y869	18318	55.02	16.65	145	0.9	82.3
-28	-28aa	17047	53.21	16.02	159	0.0	82.8
-31	-31aa	18093	56.43	16.08	155	0.0	82.6
-32	-32aa	17089	51.86	16.48	161	0.0	82.5
Y969H35-33	8835 -33aa x Y869	18835	57.79	16.30	157	0.0	81.7
-33B	-33Baa	17117	53.10	16.15	141	0.0	81.9
-35	-35aa	15783	49.08	16.10	152	0.0	82.5
-41	-41aa	16822	51.80	16.25	155	0.0	82.5
Y969H35-42	8835 -42aa x Y869	18309	55.63	16.45	159	0.0	84.2
-43	-43aa	17607	53.21	16.55	128	0.0	81.6
-45	-45aa	19153	57.81	16.52	165	0.0	81.9
-47	-47aa	18004	54.42	16.52	152	0.0	81.8
Y969H35-48	8835 -48aa x Y869	18404	58.05	15.85	161	0.0	83.2
-53	-53aa	17285	53.51	16.15	160	0.0	83.5
-54	-54aa	17402	54.72	15.90	160	0.0	83.2
-61	-61aa	16992	51.50	16.55	135	0.0	83.5

TEST 3100. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES, SALINAS, CA, 2000

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	RJAP
		Lbs	Tons	%	No.	%	%
S_1 progenies from popn-835 (cont.)							
Y969H35-74	8835 -74aa x Y869	17921	54.54	16.42	142	0.0	83.9
-75	-75aa	17154	53.71	15.98	149	0.0	82.9
-79	-79aa	16892	51.09	16.55	143	0.0	83.1
-80	-80aa	17868	57.91	15.45	149	0.0	81.4
Y969H35-81	8835 -81aa x Y869	17412	53.91	16.15	142	0.0	82.1
-82	-82aa	17951	53.21	16.88	151	0.0	82.3
-85	-85aa	18338	54.52	16.83	152	0.0	82.8
-87	-87aa	18152	54.74	16.58	159	0.0	81.1
Y969H6	8833 -5H50 x Y869	18572	54.62	17.00	157	0.0	83.8
Y969H5	8833 -5aa x Y869	18725	56.43	16.63	148	0.0	80.7
Y969H5 -52	8833 -5-2aa x Y869	17376	52.50	16.58	141	0.0	82.4
-53	-5-3aa x Y869	16741	49.38	16.98	150	0.0	83.5
Y969H5 -56	8833 -5-6aa x Y869	17694	53.59	16.52	149	0.0	82.7
-57	-5-7aa	18459	55.53	16.67	148	0.0	82.1
-58	-5-8aa	19498	58.25	16.75	137	0.0	83.4
-59	-5-9aa	17465	51.50	16.95	147	0.0	82.4
Y969H5 -510	8833 -5-10aa x Y869	19232	57.89	16.60	159	0.0	80.3
-511	-5-11aa	18363	51.90	17.70	131	0.0	83.3
-512	-5-12aa	17499	51.64	16.95	135	0.0	82.3
-513	-5-13aa	18382	52.60	17.48	149	0.0	82.3
Y969H5 -515	8833 -5-15aa x Y869	17258	51.80	16.67	149	0.0	82.5
-517	-5-17aa	18584	55.22	16.85	159	0.8	82.6
-518	-5-18aa	17368	53.71	16.18	145	0.0	82.4
-519	-5-19aa	18020	52.50	17.17	144	0.0	82.6

TEST 3100. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES, SALINAS, CA, 2000

(cont.)

Variety		Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
S_1 progenies from popn-835 (cont.)								
Y969H5	-521	8833 -5-21aa x Y869	18656	55.93	16.67	159	0.0	84.4
Y969H12	-122	8833 -12-2aa x Y869	18315	55.63	16.48	156	0.0	83.4
	-124	-12-4aa x Y869	16902	54.22	15.68	152	0.0	82.7
	-127	-12-7aa x Y869	18508	57.52	16.10	135	0.0	83.2
Mean			17930.3	54.22	16.55	151.8	0.03	82.8
LSD (.05)			1785.1	5.32	0.79	15.5	0.45	2.3
C.V. (%)			7.2	7.04	3.42	7.3	972.98	2.0
F value			2.0**	1.75**	2.18**	3.0**	0.98NS	1.5*

NOTES: From monogerm,S^f,Aa,*Rz* population 835 and progeny lines C829-3, C833-5, and C833-12, individual monogerm, Aa plants were selfed under paper bags in the greenhouse in 1998 and indexed for O-type in 1999. In 1999, the selfed families were planted in a topcross nursery and rogued to genetic male sterility (aa). These S_1-TX hybrids were evaluated in this trial. Also see B700 from Imperial Valley, 1100 for nonbolting evaluation, and 7000 for evaluation under rhizomania.

TEST 3200. RETEST OF HYBRIDS FROM 1999 WITH MONOGERM S_1 PROGENY LINES, SALINAS, CA., 2000

16 entries x 6 reps., RCB
1-row plots, 22 ft. long

Planted: March 22, 2000
Harvested: September 25, 2000

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP
		Lbs	Tons	%	No.	%
Checks						
Beta 4776R	Betaseed, 3-2-00	17827	51.53	17.30	172	84.0
Alpine	Spreckels, 3-2-00	18250	54.69	16.70	160	82.5
Y969H5	C833-5aa x Y869	18162	53.55	16.97	148	82.1
Y969H46	7869-6HO x Y869	17759	54.08	16.42	163	81.9
Y969H27	C831-4HO x Y869	19117	58.16	16.43	155	82.0
Retest of hybrids						
Y869H33-10	7833-10aa x Y769	17092	50.19	17.03	157	83.1
Y869H36-14	7836-14aa x Y769	16257	48.12	16.88	120	81.9
Y869H77-1	7837-1aa x Y769	17102	50.39	17.00	127	83.5
Y869H27-7	7831-4-7aa x Y769	17415	53.61	16.23	163	81.2
Y869H27-8	7831-4-8aa x Y769	18306	56.00	16.37	158	84.1
Y869H27-9	7831-4-9aa x Y769	16650	48.71	17.10	139	81.7
Y869H27-10	7831-4-10aa x Y769	18585	55.83	16.65	147	80.4
Y869H69-7	7869-7aa x Y769	16457	49.72	16.55	157	82.3
Y869H69-13	7869-13aa x Y769	17297	53.34	16.20	161	82.7
Y869H69-20	7869-20aa x Y769	17404	53.11	16.40	164	83.0
Y869H9-3	7808-3aa x Y769	16452	50.12	16.42	161	82.7
Mean		17508.3	52.57	16.67	153.2	82.4
LSD (.05)		1233.9	3.50	0.55	10.7	1.7
C.V. (%)		6.1	5.78	2.86	6.1	1.8
F Value		3.6**	5.35**	3.04**	13.3**	2.5**

TEST 3300. EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 2000

48 entries x 8 reps., RCB(E)
1-row plots, 22 ft. long

Planted: March 22, 2000
Harvested: September 20-21, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
3300-1: Topcrosses with C69							
Rifle	Spreckels, 3-2-00	17392	53.41	16.29	162	0.0	83.9
Beta 4776R	Betaseed, 3-2-00	18615	53.51	17.40	175	0.0	85.5
Alpine	Spreckels, 3-2-00	17917	54.12	16.56	168	0.0	83.3
Y969H3	97-C562HO x Y869	16449	49.77	16.54	162	0.0	83.9
Y969H50	C790-15CMSx Y869	18115	55.17	16.41	161	0.0	84.1
Y969H6	C790-15CMS x C833-5 x Y869	17647	52.86	16.70	158	0.0	82.1
Y969H5	C833-5aa x Y869	17800	53.21	16.73	159	0.0	81.7
Y969H12	C833-12aa x Y869	18003	55.43	16.25	153	0.0	83.6
Y969H4	C831-3aa x Y869	16450	49.28	16.67	142	0.0	83.5
Y969H27	C831-4HO x Y869	17993	54.47	16.51	161	0.0	83.4
Y969H29	C829-3aa x Y869	17110	51.60	16.58	159	0.0	83.0
Y969H35	8835aa x Y869	17909	54.42	16.46	166	0.0	83.6
Y969H38	8838aa x Y869	17186	52.96	16.24	165	0.0	84.3
Y969H69	C869aa x Y869	17309	53.26	16.25	167	0.0	83.3
Y969H87	C890aa x Y869	17361	51.65	16.81	164	0.0	83.5
Y969H56	8836HO x Y869	17362	52.60	16.51	162	0.0	83.6
Mean		17538.7	52.98	16.56	161.5	-.-	83.5
LSD (.05)		1063.7	2.90	0.43	6.5	-.-	1.5
C.V. (%)		6.1	5.52	2.67	4.1	-.-	1.9
F value		2.4*	2.79**	3.43**	9.5**	-.-	2.4**

TEST 3300. EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS, CA, 2000
48 entries x 8 reps., RCB(E). ANOVA to compare means across sets.

	Sugar Lbs	Beets Tons	Sucrose %	Beets/100' No.	Root Rot %	RJAP %
Mean	17580.0	53.00	16.59	162.5	0.02	83.5
LSD (.05)	1029.1	2.70	0.47	7.8	0.24	1.8
C.V. (%)	5.9	5.18	2.86	4.9	1114.27	2.2
F value	3.1**	4.04**	3.54**	3.7**	0.97NS	3.2**

TEST 3300. EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	RJAP
		Lbs	Tons	%	No.	%	%
3300-2: Topcrosses to Y75, C76-89 and popn-931							
Phoenix	Spreckels, 3-2-00	18261	53.91	16.94	168	0.0	85.3
Y975H50	C790-15CMS x Y875	16790	51.60	16.27	166	0.0	84.3
Y975H6	C790-15CMS x C833-5 x Y875	17515	54.07	16.21	167	0.0	82.1
Y975H5`	C833-5aa x Y875	17120	51.14	16.75	151	0.0	82.9
Topcrosses with R76-89							
R976-89H50	C790-15CMS x R76-89-5/18	17997	52.65	17.09	167	0.0	86.6
R976-89H6	C790-15CMS x C833-5 x R76-89-5/18	17284	50.94	16.96	163	0.3	82.7
R976-89H5	C833-5aa x R76-89-5/18	17511	50.79	17.24	156	0.0	82.9
R976-89H55	8835HO x R76-89-5/18	17651	52.81	16.73	164	0.0	84.1
Topcrosses with popn-931							
9931H50	C790-15CMS x RZM 8931	18144	54.77	16.58	166	0.0	83.5
9931H6	C790-15CMS x C833-5 x RZM 8931	18026	54.52	16.55	163	0.0	82.0
9931H5	C833-5aa x RZM 8931	18078	54.22	16.67	160	0.0	81.7
9931H2	C790-15CMS x C831-3 x RZM 8931	19076	56.48	16.88	160	0.0	85.2
9931H27	C831-3HO x RZM 8931	19090	60.11	15.90	166	0.0	82.4
9931H35	8835aa x RZM 8931	17660	53.16	16.60	164	0.0	83.4
9931H38	8838aa x RZM 8931	16753	50.94	16.44	161	0.0	82.9
9931H70	C869HO x RZM 8931	17806	55.28	16.11	165	0.0	82.9
Mean		17797.6	53.59	16.62	163.0	0.02	83.4
LSD (.05)		988.1	2.62	0.48	7.1	0.24	2.2
C.V. (%)		5.6	4.95	2.90	4.4	1137.30	2.6
F value		3.7**	6.85**	4.63**	3.2**	1.00NS	2.9**

TEST 3300. EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Root Rot %	RJAP %
3300-3: Topcrosses with MM,S^f,A:aa popns							
Beta 4430R	4430.9041, 9-8-99	19406	55.93	17.36	170	0.0	87.0
Topcrosses with popn-941							
9941H50	C790-15CMS x 941(C)	17712	54.02	16.40	169	0.0	83.6
9941H6	C790-15CMS x C833-5 x 941(C)	17732	51.95	17.05	161	0.0	82.9
9941H35	8835aa x 941(C)	16541	50.09	16.51	160	0.0	84.6
Topcrosses with popn-CR11							
CR911H50	C790-15CMS x CR811(C)	17582	53.71	16.36	164	0.0	83.9
CR911H6	C790-15CMS x C833-5 x CR811(C)	16755	51.40	16.29	156	0.0	82.2
CR911H35	8835aa x CR811(C)	16746	51.70	16.20	160	0.3	82.3
Topcrosses with popn-933							
9933H50	C790-15CMS x 8933	17377	52.60	16.52	167	0.0	83.4
9933H6	C790-15CMS x C833-5 x 8933	17360	51.45	16.88	161	0.0	81.6
9933H35	8835aa x 8933	17740	52.88	16.77	162	0.0	84.2
Topcrosses with popn-932							
9932H50	C790-15CMS x 8932	17173	51.14	16.79	163	0.0	83.6
9932H35	8835aa x 8932	16613	50.69	16.40	161	0.0	83.5
Topcrosses with popn-924							
9924H50	C790-15CMS x RZM 8924	17396	52.20	16.66	169	0.0	83.6
9924H35	8835aa x RZM 8924	17444	52.91	16.50	159	0.4	82.6
Topcrosses with popn-926							
9926H50	C790-15CMS x 8926	17079	52.00	16.41	163	0.0	83.6
9926H35	8835aa x 8926	17804	54.22	16.42	161	0.0	82.3
Mean		17403.6	52.43	16.60	162.9	0.04	83.4
LSD (.05)		1056.5	2.71	0.46	7.7	0.34	1.6
C.V. (%)		6.1	5.22	2.78	4.8	775.83	2.0
F value		3.2**	2.37*	3.53**	2.3**	1.00NS	4.7**

TEST 3300. EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield		Sucrose	Beets/ 100'	Root Rot	RJAP
		Sugar	Beets				
		Lbs	Tons	%	No.	%	%

NOTES: Grown in area following methyl bromide/chloropricin fumigation and one crop of strawberries. No evidence of soilborne diseases except minor root aphid infestation. Powdery mildew controlled. Possibly natural infection with beet western yellows virus. About 260 units of nitrogen applied. See test 7200 for performance under rhizomania.

For 3300-2: aa = genetic male sterility. HO = CMS = cytoplasmic male sterility. Prefix "C" means line has been released from Salinas, CA. Y875 ≈ C31/6 with C51 (R22) resistance to rhizomania. R76-89-5/18 is a mix of C76-89-5 and C76-89-18 pollinators. Popn-931 is the base MM,S^f,Aa,*Rz* random-mated population being improved by S_1 recurrent selection.

For 3300-3: Population 941 combines popn-931 types with C76-89-5, et al. Popn-CR11 combines popn-931 types with Cercospora resistance. Popn-933 combines popn-931 with root aphid resistance. Popn-932 combines popn-931 with high curly top resistant sources. Popn-924 combines popn-931 types with virus yellows resistance from advanced open-pollinated lines. Popn-926 combines popn-93 with resistance to rhizomania from C51 (R22). 8835,8836,8838,C869, and C890 are mm,S^f,Aa,*Rz* populations.

TEST 3400. HYBRID PERFORMANCE OF MONOGERM S_2 PROGENY LINES, SALINAS, CA., 2000

36 entries x 4 reps., RCB
1-row plots, 22 ft. long

Planted: March 22, 2000
Harvested: September 20, 2000

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP
		Lbs	Tons	%	No.	%
Checks						
Alpine	Spreckels, 3-2-00	17997	54.42	16.52	166	82.9
B4776R	4776.9002, 9-8-99	17497	51.29	17.05	180	84.0
Y969H50	C790-15CMS x Y869	18304	55.53	16.48	169	83.3
Y969H10	8810mmaa x Y869	18058	55.43	16.27	160	82.4
Y969H48	8848aa x Y869	17425	53.61	16.25	159	82.0
S_2 progeny topcrosses						
Y969H9 - 24	8808 - 2-4aa x Y869	18651	57.04	16.35	156	83.6
- 25	- 2-5aa x Y869	17405	52.10	16.70	156	83.9
- 26	- 2-6aa x Y869	17326	55.53	15.63	160	83.0
- 31	8808 - 3-1aa x Y869	17393	53.31	16.35	136	84.5
Y969H9 - 32	- 3-2aa x Y869	17520	53.81	16.27	157	82.8
- 33	- 3-3aa x Y869	17224	50.89	16.90	144	82.1
- 35	- 3-5aa x Y869	17135	50.59	16.92	144	82.4
- 36	8808 - 3-6aa x Y869	17795	53.71	16.55	140	82.3
Y969H9 - 41	8808 - 4-1aa x Y869	16979	52.40	16.20	156	81.6
- 42	- 4-2aa x Y869	16442	49.78	16.50	143	82.7
- 45	- 4-5aa x Y869	16808	51.40	16.35	147	82.7
Y969H9 - 46	8808 - 4-6aa x Y869	17056	51.76	16.48	141	81.6
- 47	- 4-7aa	17203	51.40	16.73	156	83.3
- 72	- 7-2aa	17107	51.19	16.70	157	82.3
- 74	- 7-4aa	17737	53.11	16.70	168	81.8

TEST 3400. HYBRID PERFORMANCE OF MONOGERM S_2 PROGENY LINES, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %
S_2 progeny topcrosses (cont.)						
Y969H9 - 85	8808 - 8-5aa x Y869	17110	52.75	16.23	149	81.2
- 92	- 9-2aa	18741	55.95	16.75	155	83.4
- 93	- 9-3aa	17060	51.50	16.55	157	83.5
- 94	- 9-4aa	17086	50.79	16.83	158	82.2
Y969H9 - 96	8808 - 9-6aa x Y869	16920	51.50	16.42	161	82.3
- 97	- 9-7aa x Y869	16837	50.19	16.77	151	82.7
-913	- 9-13aa x Y869	16586	48.27	17.17	153	82.6
-121	8808 -12-1aa x Y869	17581	54.42	16.17	156	83.4
Y969H9 -123	8808 -12-3aa x Y869	16122	48.78	16.52	128	83.1
-124	-12-4aa x Y869	18555	57.44	16.15	152	82.7
-125	-12-5aa x Y869	17056	52.71	16.17	142	83.3
-126	-12-6aa x Y869	18672	56.53	16.52	161	84.0
Y969H9 -131	8808 -13-1aa x Y869	16699	49.88	16.73	141	83.8
-132	-13-2aa x Y869	17439	53.41	16.33	156	82.6
-166	8808 -16-6aa x Y869	16870	53.41	15.80	149	81.9
-167	-16-7aa x Y869	16961	51.70	16.40	147	82.6
Mean		17371.0	52.71	16.48	153.1	82.8
LSD (.05)		1786.0	5.00	0.63	13.8	2.0
C.V. (%)		7.3	6.76	2.74	6.4	1.7
F value		1.0NS	1.64*	2.02**	4.2**	1.1NS

NOTES: Populations 8808,8810, and 8848 are based upon mm,S^f,Aa popn-790 but have resistance to rhizomania backcrossed in from *Beta vulgaris* ssp *maritima* through C51 (R22). From popn-808, S_2 monogerm, type-O progenies were produced and their genetic male sterile segregants top crossed to C69. These S_2-TX are evaluated in this trial. See Test B799 for S_1-TX performance; …

TEST 6400. PERFORMANCE OF EXPERIMENTAL HYBRIDS with F_1 POLLINATORS UNDER RHIZOMANIA, SALINAS, CA., 2000

12 entries x 8 reps., RCB
1-row plots, 22 ft. long

Planted: May 1, 2000
Harvested: November 9, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %
Checks						
KW6770	susc. check, 1997	4781	13.31	17.88	160	85.8
Beta 4776R	L4776.9002, 9-8-99	10396	29.69	17.50	181	85.4
931H5	8833-5aa x RZM 8931	10281	28.72	17.92	122	84.4
9931H27	8831-4HO x RZM 8931	10560	30.61	17.24	170	84.4
Hybrids with Sources of VYR						
R776-89-5H50	C790-15CMS x R576-89-5	8406	23.58	17.84	174	84.6
8913-70H50	C790-15CMS x 6913-70	8742	25.49	17.21	148	84.9
9931H50	c790-15CMS x RZM 8931	9048	26.24	17.26	176	85.7
Y969H50(Iso)	C790-15CMS x RZM-ER-% Y769	8299	23.82	17.42	180	84.1
Hybrids with Combined Sources						
8935H50	C790-15CMS x R776-89-5H13	8730	25.30	17.29	183	83.8
8936H50	C790-15CMS x RZM R776-89-5H31	9427	26.69	17.69	157	83.5
8939H50	C790-15CMS x RZM Y769H31	8664	25.37	17.06	167	84.2
9941H50	C790-15CMS x 941(C)	8133	23.59	17.29	170	85.5
Mean		8789.0	25.20	17.47	165.8	84.7
LSD (.05)		1287.8	3.78	0.51	14.9	1.8
C.V. (%)		14.7	15.07	2.94	9.0	2.1
F value		11.0**	10.77**	2.62**	10.6**	1.5NS

TEST 6800. EVALUATION OF TESTCROSS HYBRIDS UNDER RHIZOMANIA, SALINAS, CA., 2000

48 entries x 8 reps., RCB(E); 3 sets each 16 x 8, RCB(E)
1-row plots, 22 ft. long

Planted: May 2, 2000
Harvested: November 6, 2000

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	RJAP
		Lbs	Tons	%	No.	%	%
6800-1: Testcrossed with MM breeding lines							
Beta 4430R	4430.9041, 9-8-99	11414	31.29	18.29	171	0.0	85.7
Alpine	X612401, 9-10-99	9421	27.46	17.20	156	0.0	84.4
Y969H50 (Iso)	C790-15CMS x RZM-ER-% Y769	9687	28.36	17.10	174	0.0	85.5
R978H50	C790-15CMS x RZM-ER-% R778	10560	30.46	17.39	180	0.3	83.8
R980H50	C790-15CMS x RZM-ER-% R780/2,...	9861	29.07	17.02	188	0.0	86.1
R970H50	C790-15CMS x RZM-ER-% R770	9546	27.74	17.21	170	1.7	84.1
R776-89-5H50	C790-15CMS x R576-89-5	9319	26.92	17.34	174	0.0	84.7
US H11	1999 production, susc. ck.	5379	18.43	14.79	174	0.0	83.6
R976-89H50	C790-15CMS x R76-89-5/18	9644	28.52	17.00	174	0.0	85.1
9941H50	C790-15CMS x RZM 941(C)	9482	28.29	16.83	166	0.0	85.1
9931H50	C790-15CMS x RZM 8931	9996	30.07	16.67	174	0.0	85.7
9924H50	C790-15CMS x RZM 8924	11095	32.70	16.99	181	0.0	84.7
9932H50	C790-15CMS x RZM 8932	9564	28.12	17.05	181	0.7	84.7
9933H50	C790-15CMS x 8933	10263	30.93	16.61	174	0.0	83.9
CR909-1H50	C790-15CMS x RZM R709-1	11768	34.11	17.27	164	0.0	84.2
CR911H50	C790-15CMS x CR811(C)	10573	32.36	16.38	174	0.0	84.6
Mean		9848.3	29.05	16.95	173.5	0.2	84.8
LSD (.05)		1109.0	3.28	0.56	11.8	1.0	2.2
C.V. (%)		11.4	11.40	3.34	6.9	645.1	2.6
F value		12.6**	9.00**	12.70**	3.1**	1.4NS	0.9NS

TEST 6800. EVALUATION OF TESTCROSS HYBRIDS UNDER RHIZOMANIA, 2000.
48 entries x 8 reps., RCB(E). ANOVA across tests to compare means.

		Sugar	Beets	Sucrose	Beets/100'	Root Rot	RJAP
Mean		9971.2	29.36	17.01	170.5	0.1	84.4
LSD (.05)		1177.5	3.53	0.54	13.3	0.9	1.9
C.V. (%)		12.0	12.20	3.22	7.9	654.6	2.3
F value		7.7**	6.71**	7.82**	2.8**	1.1NS	1.6*

TEST 6800. EVALUATION OF TESTCROSS HYBRIDS UNDER RHIZOMANIA, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
6800-2:	Testcrossed with lines with *Bvm* germplasm						
Beta 4776R	4776.9002, 9-8-99	10853	31.13	17.44	162	0.0	85.5
Z925H50	C790-15CMS x RZM-ER-% Z725(C)	10072	30.03	16.80	175	0.0	83.7
R940H50	C790-15CMS x RZM-ER-% R740	10943	33.42	16.40	170	0.0	85.0
R954H50	C790-15CMS x RZM-ER-% x R746,R754	10828	33.27	16.31	175	0.0	84.5
R936H50	C790-15CMS x RZM-ER-% R736	10889	33.61	16.23	179	0.0	84.6
R943H50	C790-15CMS x RZM-ER-% R643	10940	32.22	16.99	157	0.0	83.6
P909H50	C790-15CMS x PMR-RZM P809,P810	8669	26.32	16.51	178	0.0	84.5
P911H50	C790-15CMS x PMR-RZM P811	9098	27.50	16.58	176	1.0	85.0
P912H50	C790-15CMS x PMR-RZM P812	10165	31.03	16.49	169	1.1	85.4
Y967H50	C790-15CMS x RZM-ER-% Y767	9525	27.97	17.09	180	0.3	85.3
Y971H50	C790-15CMS x RZM-ER-% Y771	9883	29.17	17.00	173	0.0	85.9
9934H50	C790-15CMS x RZM 8934(C)	10110	30.36	16.66	178	0.3	84.8
9926H50	C790-15CMS x RZM 8926	10612	31.41	16.90	180	0.0	84.1
Y975H50	C790-15CMS x RZM Y875	10655	31.44	16.95	174	0.0	85.1
Y975H5	C833-5aa x RZM Y875	11407	33.13	17.21	168	0.0	82.6
Y975H6	C833-5H50 x RZM Y875	10735	31.27	17.16	167	0.0	85.1
Mean		10336.5	30.83	16.80	172.6	0.2	84.7
LSD (.05)		1073.4	3.29	0.53	10.7	1.0	1.9
C.V. (%)		10.5	10.78	3.18	6.3	630.8	2.2
F value		3.8**	3.47**	3.52**	2.9**	0.9NS	1.6NS

Notes: See tests 100 & 2900 at Salinas and B100 at Brawley. HO = CMS. aa = genetic male sterility.
C833-5H50 = C790-15CMS x C833-5.

TEST 6800. EVALUATION OF TESTCROSS HYBRIDS UNDER RHIZOMANIA, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	RJAP %
6800-3: Topcrosses							
Phoenix	Spreckels, 2000	7729	21.56	18.04	148	0.0	84.2
Y969H50(Sp)	C790-15CMS x Y869	9323	28.17	16.55	173	0.0	84.7
Y969H5	C833-5aa x Y869	11025	31.08	17.74	168	0.0	83.6
Y969H6	C833-5H50 x Y869	10539	31.08	16.98	163	0.0	84.4
Y969H3	97-C562HO x Y869	7047	20.77	17.00	170	0.0	84.0
Y969H45	C867-1HO x Y869	8876	26.16	17.00	169	0.6	82.9
Y969H46	7869-6HO x Y869	10006	29.03	17.26	169	0.0	84.3
Y969H12	C833-12aa x Y869	9145	26.69	17.19	157	0.0	83.9
Y969H4	C831-3aa x Y869	10742	31.17	17.26	155	0.6	83.7
Y969H27	C831-4HO x Y869	10093	29.36	17.21	163	0.0	83.9
Y969H29	C829-3aa x Y869	8500	25.06	17.00	163	0.0	82.6
Y976-89H5	C833-5aa x R76-89-5/18	10237	28.76	17.83	162	0.0	82.9
Y976-89H6	C833-5H50 x R76-89-5/18	9719	27.35	17.80	176	0.0	84.5
9931H5	C833-5aa x RZM 8931	11872	34.38	17.27	166	0.0	82.5
9931H6	C833-5H50 x RZM 8931	10419	30.47	17.16	170	0.0	85.1
9941H6	C833-5H50 x 941(C)	10393	30.12	17.27	175	0.3	84.1
Mean		9729.0	28.20	17.29	165.4	0.1	83.8
LSD (.05)		932.0	2.67	0.49	13.0	0.6	1.7
C.V. (%)		9.7	9.56	2.86	8.0	642.7	2.1
F value		14.0**	14.02**	4.89**	2.5**	1.0NS	1.6NS

Note: C833-5H50 = C790-15CMS x C833-5. HO = CMS. aa = genetic male sterility.
8931 = popn-931 = MM,S^f,Aa,Rz base population.

TEST 6900. PERFORMANCE OF HYBRIDS WITH S_1 PROGENY POLLINATORS UNDER RHIZOMANIA, SALINAS, CA., 2000

48 entries x 8 reps., RCB(E); 3 subtests 16 x 8, RCB(E)
1-row plots, 22 ft. long

Planted: May 2, 2000
Harvested: October 18 & 19, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	RJAP %
6900-1: Checks and retests from 1999						
Alpine	Spreckels, 3-2-00	8708	28.26	15.48	170	83.6
Beta 4430R	4430.9041, 9-8-99	9775	29.93	16.35	180	83.4
9918-21H50	C790-15CMS x RZM 8918-21	9457	31.22	15.14	186	83.7
8925-19H50	C790-15CMS x 6925-19	10005	33.27	15.09	186	83.9
Z825-6H50	C790-15CMS x Z625-6	9605	30.33	15.84	170	84.0
Z825-9H50	C790-15CMS x Z625-9	9587	28.64	16.76	170	82.5
8929-112H50	C790-15CMS x 6929-112	10073	31.03	16.23	168	83.5
8929-114H50	C790-15CMS x 6929-114	10288	33.25	15.52	178	82.5
8929-115H50	C790-15CMS x 6929-115	8250	26.54	15.56	165	83.5
8930-19H50	C790-15CMS x 6930-19	10287	32.49	15.81	174	83.3
8927-29H50	C790-15CMS x 6927-29	8757	26.69	16.49	169	82.4
8911-4-10H50	C790-15CMS x 6911-4-10	10300	32.60	15.79	176	81.2
9941H50	C790-15CMS x 941(C)	9313	30.17	15.41	176	84.7
9941H6	8833-5H50 x 941(C)	9419	29.75	15.82	170	82.5
R976-89H5	8833-5aa x R76-89-5/18	10480	31.41	16.67	164	83.8
US H11	1999 prod., susc. ck.	5357	19.38	13.77	184	84.1
Mean		9353.9	29.69	15.73	174.0	83.3
LSD (.05)		894.9	2.89	0.52	11.0	2.1
C.V. (%)		9.7	9.79	3.31	6.4	2.5
F value		15.1**	11.23**	15.73**	3.1**	1.4NS

TEST 6900. PERFORMANCE OF HYBRIDS WITH S_1 PROGENY POLLINATORS UNDER RHIZOMANIA, SALINAS, CA., 2000
48 entries x 8 reps., RCB(E). ANOVA across tests to compare means.

Mean	8935.1	28.75	15.55	176.6	83.2
LSD (.05)	1106.1	3.48	0.57	12.5	2.0
C.V. (%)	12.6	12.30	3.70	7.2	2.4
F value	9.4**	8.48**	7.65**	2.3**	1.5*

TEST 6900. PERFORMANCE OF HYBRIDS WITH S_1 PROGENY POLLINATORS UNDER RHIZOMANIA, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	RJAP %
6900-2: Hybrids with popns-931 & -924, et al.						
Beta 4776R	Betaseed, 3-2-00	10210	32.60	15.69	182	84.1
9931H50	C790-15CMS x RZM 8931	8547	28.45	15.07	179	83.6
Z925H50	C790-15CMS x RZM-ER-% Z725(C)	9348	30.46	15.38	178	82.2
9931-18H50	C790-15CMS x 7931-18	8532	27.40	15.60	187	83.6
9931-24H50	C790-15CMS x 7931-24	9599	29.87	16.10	180	82.0
9931-29H50	C790-15CMS x 7931-29	8790	29.45	14.96	179	83.4
9924H50	C790-15CMS x 8924	8862	29.07	15.26	177	83.6
9924-2H50	C790-15CMS x 7924-2	8843	28.29	15.61	169	83.2
9924-6H50	C790-15CMS x 7924-6	8447	27.35	15.44	184	82.1
9924-10H50	C790-15CMS x 7924-10	8989	28.86	15.60	180	84.5
9924-74H50	C790-15CMS x 7924-74%	8719	28.45	15.39	170	83.3
9931H5	8833-5aa x RZM 8931	10544	33.18	15.94	168	81.7
9924-78H50	C790-15CMS x 7924-78	8760	28.02	15.65	183	81.8
9924-114H50	C790-15CMS x 7924-114VY	7947	24.97	15.95	172	82.1
9926H50	C790-15CMS x 8926	9328	30.93	15.11	176	82.8
9927-4H50	C790-15CMS x 7927-4VY	11233	36.82	15.30	177	82.9
Mean		9168.7	29.6	15.50	177.5	82.9
LSD (.05)		945.8	2.8	0.48	10.7	1.9
C.V. (%)		10.4	9.7	3.13	6.1	2.3
F value		6.5**	7.5**	3.60**	2.0*	1.6NS

Notes for 6900-2: From improved MM,S^f,Aa,*Rz* populations, individual plants were selfed in the greenhouse under paper bags in 1997. In 1998, S_1 progeny lines per se were evaluated under virus yellows, rhizomania, and bolting conditions. Based upon these S_1 tests, lines were selected and testcrossed to the common tester C790-15CMS. These experimental hybrids were evaluated in 2000 at Brawley and Salinas. From Brawley, see tests B300, and B600. From Salinas see tests 100, 200, 2100, 4400, 6300, and 3000.

TEST 6900. PERFORMANCE OF HYBRIDS WITH S_1 PROGENY POLLINATORS UNDER RHIZOMANIA, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP
		Lbs	Tons	%	No.	%
6900-3: Hybrids with popns-929 & -930, et al.						
9927-17H50	C790-15CMS x 7927-17VY	9570	32.18	14.93	187	84.3
9928-34H50	C790-15CMS x 7928-34	10190	33.94	15.01	187	82.9
9928-107H50	C790-15CMS x 7928-107	8448	28.31	15.05	182	82.3
R976-89-18H50	C790-15CMS x R576-89-18	7824	26.07	15.02	174	83.8
9929-4H50	C790-15CMS x 7929-4VY	8489	26.92	15.89	173	82.1
9929-9H50	C790-15CMS x 7929-9VY	9822	31.08	15.85	176	83.3
9939-45H50	C790-15CMS x 7929-45	8578	27.45	15.68	174	84.0
9929-47H50	C790-15CMS x 7929-47VY	7943	25.64	15.50	176	84.3
9929-48H50	C790-15CMS x 7929-48VY	6373	21.85	14.65	180	83.6
9929-56H50	C790-15CMS x 7929-56VY	6684	21.67	15.31	184	84.9
9929-62H50	C790-15CMS x 7929-62VY	9301	30.27	15.39	186	83.3
R978H50	C790-15CMS x RZM-ER-% R778	9410	29.93	15.71	179	83.0
9930-17H50	C790-15CMS x 7930-17VY	7095	24.13	14.76	181	84.3
9930-32H50	C790-15CMS x 7930-32	6098	20.36	14.93	177	82.8
9930-35H50	C790-15CMS x 7930-35	9447	28.98	16.36	179	82.1
Phoenix	Spreckels, 3-2-00	7247	22.12	16.39	157	83.5
Mean		8282.6	26.93	15.40	178.3	83.4
LSD (.05)		1144.6	3.55	0.57	10.7	1.9
C.V. (%)		14.0	13.32	3.75	6.1	2.3
F value		10.1**	10.38**	6.99	3.8**	1.6NS

NOTES for 6900-1: Z625-9 & 6911-4-10 were released as CZ25-9 and C911-4-10mm in 2000. C833-5 was rereleased in 2000. C833-5H50 = C790-15CMS x C833-5. R76-89-5/18 is a mix and F_1 hybrid between C76-89-5 and C76-89-18. Progeny lines Z625-6 & -9 have ZZ germplasm from Polish accessions. 8918-21 & 8918-21 are S_1 lines from popn-931. 6929-112,-114, & -115 are S_1 lines from a population cross between popn-931 and C31 types. 6930-19 is an S_1 line from a popn cross between C931 and C78. 6927-29 has *Bvm* (C51) germplasm.

TEST 7000. HYBRID PERFORMANCE MONOGERM S_1 PROGENY LINES UNDER RHIZOMANIA, SALINAS, CA., 2000

72 entries x 4 reps., RCB(E)
1-row plots, 22 ft. long

Planted: May 2, 2000
Harvested: October 17-18, 2000

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP
		Lbs	Tons	%	No.	%
Checks						
Beta 4776R	Betaseed, 3-1-00	10149	32.27	15.68	183	85.1
Beta 4430R	4430.9041, 9-8-99	9130	27.64	16.52	168	83.9
Alpine	Spreckels, 3-2-00	8649	27.92	15.55	153	82.5
US H11	1999 production, susc. ck.	5478	20.01	13.60	176	84.1
Y969H50	C790-15CMS x Y869	8591	29.41	14.50	173	83.8
S_1 progenies from line C829-3						
Y969H29 -31	8829 -3 - 1aa x Y869	7790	25.74	15.10	173	82.1
-35	- 5aa x Y869	8145	26.54	15.52	177	83.6
-310	-10aa x Y869	6648	22.05	15.10	175	82.8
S_1 progenies from popn-835						
Y969H35	8835aa x Y869	8745	28.07	15.53	182	82.8
Y969H35 - 1	8835 - 1aa x Y869	8432	27.40	15.43	180	82.5
Y969H35 - 2	8835 - 2aa	8259	27.11	15.27	165	82.8
Y969H35 - 3	8835 - 3aa	8405	27.84	15.23	155	81.2
Y969H35 - 4	8835 - 4aa x Y869	7679	25.05	15.48	165	83.0
- 6	- 6aa	9740	31.70	15.38	181	82.2
- 7	- 7aa	7656	25.68	14.90	184	82.3
- 8	- 8aa	6914	24.36	14.10	157	83.8
Y969H35 - 9	8835 - 9aa x Y869	8043	25.88	15.57	159	84.8
-10	-10aa	8150	26.83	15.15	168	83.2
-11	-11aa	9679	30.46	15.95	169	81.9
-12	-12aa	8950	27.97	16.00	158	82.6
Y969H35 -13	8835 -13aa x Y869	8017	26.54	15.18	178	82.0
-14	-14aa	8100	25.97	15.52	158	83.1
-16	-16aa	8240	26.83	15.38	168	83.1
-17	-17aa	8290	26.16	15.85	173	82.2

TEST 7000. HYBRID PERFORMANCE MONOGERM S_1 PROGENY LINES UNDER RHIZOMANIA, SALINAS, CA., 2000 (cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP
		Lbs	Tons	%	No.	%
S_1 progenies from popn-835 (cont.)						
Y969H35 -18	8835 -18aa x Y869	8330	27.11	15.35	182	81.8
-22	-22aa	7573	24.82	15.33	169	83.5
-24	-24aa	8085	26.35	15.35	169	85.1
-25	-25aa	8247	27.56	14.95	180	83.2
Y969H35 -26	8835 -26aa x Y869	8685	27.31	15.90	159	82.9
-28	-28aa	8565	27.88	15.45	174	83.1
-31	-31aa	8524	27.88	15.40	177	84.0
-32	-32aa	9064	28.55	15.93	189	82.6
Y969H35 -33	8835-33aa x Y869	8246	27.06	15.32	181	83.1
-33B	-33Baa	7048	22.37	15.80	162	80.7
-35	-35aa	7670	25.31	15.15	175	81.6
-41	-41aa	8411	26.48	15.88	178	82.4
Y969H35 -42	8835 -42aa x Y869	7399	25.49	14.58	178	82.0
-43	-43aa	7901	25.40	15.57	141	80.0
-45	-45aa	9034	28.64	15.83	185	81.9
-47	-47aa	8175	29.98	13.68	175	77.9
Y969H35 -48	8835 -48aa x Y869	8907	29.79	14.95	177	83.1
-53	-53aa	7574	25.11	15.13	166	80.5
-54	-54aa	8218	26.73	15.40	176	83.4
-61	-61aa	8363	27.05	15.50	153	83.0
Y969H35 -74	8835 -74aa x Y869	8413	26.92	15.63	166	82.7
-75	-75aa	8941	29.69	15.10	164	82.6
-79	-79aa	8434	26.35	16.02	165	82.3
-80	-80aa	7903	25.78	15.35	181	83.0
Y969H35 -81	8835 -81aa x Y869	8433	27.02	15.60	172	83.4
-82	-82aa	7859	26.16	15.07	175	82.8
-85	-85aa	8866	27.31	16.25	175	82.7
-87	-87aa	9413	29.79	15.77	190	83.4

TEST 7000. HYBRID PERFORMANCE MONOGERM S_1 PROGENY LINES UNDER RHIZOMANIA, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP
		Lbs	Tons	%	No.	%
S_1 progenies from line C833-5						
Y969H6	8833 -5H50 x Y869	8220	26.96	15.23	175	83.8
Y969H5	8833 -5aa x Y869	9976	30.45	16.40	148	82.0
Y969H5 -52	8833 -5-2aa x Y869	10352	31.54	16.42	153	82.6
-53	-5-3aa x Y869	11070	34.47	16.05	167	81.6
Y969H5 -56	8833 -5-6aa x Y869	7645	24.93	15.32	130	83.0
-57	-5-7aa	9851	31.03	15.90	167	83.4
-58	-5-8aa	10407	31.98	16.25	162	81.3
-59	-5-9aa	9703	29.50	16.45	166	82.1
Y969H5 -510	8833 -5-10aa x Y869	10275	31.89	16.08	172	84.1
-511	-5-11aa	9568	28.58	16.73	152	81.0
-512	-5-12aa	9676	29.98	16.15	176	81.3
-513	-5-13aa	9635	29.04	16.60	169	82.7
Y969H5 -515	8833 -5-15aa x Y869	8353	26.16	15.98	153	81.1
-517	-5-17aa	9418	28.92	16.28	173	83.4
-518	-5-18aa	8436	26.13	16.17	156	81.5
-519	-5-19aa	9490	29.36	16.15	167	82.8
Y969H5 -521	8833 -5-21aa x Y869	8961	28.29	15.85	178	83.3
Y969H12 -122	8833 -12-2aa x Y869	8214	26.16	15.80	170	82.7
-124	-12-4aa x Y869	7588	24.63	15.48	170	82.6
-127	-12-7aa x Y869	7724	24.35	15.88	175	84.4
Mean		8537.9	27.44	15.55	169.3	82.6
LSD (.05)		1802.2	5.56	0.84	22.8	3.0
C.V. (%)		15.2	14.54	3.85	9.7	2.6
F value		2.2**	1.53*	4.00**	1.9**	1.2NS

TEST 7100. RETEST UNDER RHIZOMANIA OF HYBRIDS FROM 1999 WITH MONOGERM S_1 PROGENY LINES, SALINAS, CA., 2000

16 entries x 6 reps., RCB
1-row plots, 22 ft. long

Planted: May 2, 2000
Harvested: October 18, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %
Checks						
Beta 4776R	Betaseed, 3-2-00	9744	31.06	15.67	179	83.3
Alpine	Spreckels, 3-2-00	8098	25.91	15.63	164	82.3
Y969H5	8833-5aa x Y869	9677	30.49	15.87	158	82.5
Y969H46	7869-6HO x Y869	9024	29.85	15.18	176	83.1
Y969H27	8831-4HO x Y869	8464	28.83	14.68	170	81.7
Retest of hybrids						
Y869H33-10	7833-10aa x Y769	7881	25.23	15.55	172	81.0
Y869H36-14	7836-14aa x Y769	7962	25.08	15.90	150	83.5
Y869H77-1	7837-1aa x Y769	8362	27.25	15.37	156	82.6
Y869H27-7	7831-4-7aa x Y769	9502	30.04	15.80	167	81.8
Y869H27-8	7831-4-8aa x Y769	7605	24.49	15.67	161	81.2
Y869H27-9	7831-4-9aa x Y769	9267	28.64	16.25	151	82.0
Y869H27-10	7831-4-10aa x Y769	9786	31.07	15.77	139	82.2
Y869H69-7	7869-7aa x Y769	8226	26.23	15.73	189	82.6
Y869H69-13	7869-13aa x Y769	8042	26.86	14.98	192	82.9
Y869H69-20	7869-20aa x Y769	7373	24.00	15.38	163	83.0
Y869H9-3	7808-3aa x Y769	7022	23.65	14.85	189	82.1
Mean		8502.2	27.42	15.52	167.3	82.4
LSD (.05)		1372.4	4.32	0.69	19.1	2.6
C.V. (%)		14.0	13.68	3.85	9.9	2.8
F value		3.3**	2.87**	2.94**	5.0**	0.6NS

TEST 7200. EVALUATION OF EXPERIMENTAL HYBRIDS UNDER RHIZOMANIA, SALINAS, CA., 2000

40 entries x 6 reps., RCB
1-row plots, 22 ft. long

Planted: May 2, 2000
Harvested: October 17, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	RJAP %
Topcrosses with C69						
US H11	1999 prod., susc. ck.	6374	24.06	13.17	186	82.7
Beta 4776R	Betaseed, 3-2-00	10185	32.33	15.82	185	83.4
Alpine	Spreckels, 3-2-00	8459	27.43	15.45	172	82.3
Y969H50	C790-15CMSx Y869 (C69)	7724	27.25	14.15	176	82.7
Y969H6	C833-5H50 x Y869	9316	30.87	15.20	168	81.7
Y969H5	C833-5aa x Y869	9796	32.33	15.17	166	80.7
Y969H35	8835aa x Y869	8723	29.00	15.03	179	82.3
Y969H38	8838aa x Y869	8197	27.69	14.85	172	83.6
Y969H69	C869aa x Y869	8833	29.96	14.72	186	82.8
Y969H87	C890aa x Y869	8679	28.01	15.43	176	84.5
Y969H56	8836HO x Y869	8754	29.60	14.82	167	81.4
Topcrosses to Y75						
Phoenix	Spreckels, 3-2-00	7552	23.49	16.32	166	82.0
Y975H50	C790-15CMS x Y875	10208	34.31	14.92	177	82.5
Y975H6	C833-5H50 x Y875	9616	31.83	15.15	172	81.6
Y975H5	C833-5aa x Y875	10614	33.80	15.70	167	81.6
Topcrosses with R76-89						
R976-89H50	C790-15CMS x R76-89-5/18	8534	27.44	15.62	182	82.3
R976-89H6	C833-5H50 x R76-89-5/18	8901	28.45	15.67	184	83.7
R976-89H5	C833-5aa x R76-89-5/18	8613	26.67	16.22	164	80.9
Topcrosses with popn-931						
9931H50	C790-15CMS x RZM 8931	8938	29.28	15.42	173	82.8
9931H6	C833-5H50 x RZM 8931	8813	30.42	14.57	161	81.8
9931H5	C833-5aa x RZM 8931	8861	28.01	15.97	129	82.5
9931H2	C831-3H50 x RZM 8931	8234	27.82	14.95	180	82.4
9931H27	C831-3HO x RZM 8931	7058	24.44	14.85	166	80.8
9931H35	8835aa x RZM 8931	8582	28.62	15.12	176	81.9
Topcrosses with MM,S^f,A:aa popns						
Beta 4430R	4430.9041, 9-8-99	9446	28.39	16.72	185	83.6

TEST 7200. EVALUATION OF EXPERIMENTAL HYBRIDS UNDER RHIZOMANIA, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %
Topcrosses with popn-941						
9941H50	C790-15CMS x 941(C)	8147	27.50	14.82	167	83.1
9941H6	C833-5H50 x 941(C)	8814	28.39	15.55	180	82.4
9941H35	C835aa x 941(C)	8060	27.94	14.45	176	81.6
Topcrosses with popn-CR11						
CR911H50	C790-15CMS x CR811(C)	8937	30.87	14.50	188	82.9
CR911H6	C833-5H50 x CR811(C)	9269	31.19	14.88	177	83.2
CR911H35	8835aa x CR811(C)	8765	29.22	15.02	178	82.3
Topcrosses with popn-933						
9933H50	C790-15CMS x 8933	7823	26.90	14.58	176	84.0
9933H6	C833-5H50 x 8933	8670	28.78	15.07	173	81.3
9933H35	8835aa x 8933	8061	27.24	14.80	175	83.2
Topcrosses with popn-932						
9932H50	C790-15CMS x 8932	8472	28.45	14.93	169	83.9
9932H35	8835aa x 8932	7795	25.14	15.52	173	82.5
Topcrosses with popn-924						
9924H50	C790-15CMS x RZM 8924	8511	28.39	15.08	183	82.4
9924H35	8835aa x RZM 8924	8831	29.53	15.07	177	82.6
Topcrosses with popn-926						
9926H50	C790-15CMS x 8926	9185	30.87	14.92	175	80.9
9926H35	8835aa x 8926	9381	31.40	14.98	173	80.8
Mean		8693.3	28.83	15.13	173.9	82.4
LSD (.05)		1412.6	4.67	0.66	14.2	2.1
C.V. (%)		14.3	14.22	3.81	7.2	2.3
F value		2.6**	2.08**	6.91**	3.8**	1.5*

Notes: See test 3300, B500, and 100. HO = CMS. aa = genetic ms. C833-5H50 = C790-15CMS x C833-5. 8835, 8838, C869, C890, 8836 are monogerm populations.

TEST 6600. WESTERN SUGAR, U of I, & USDA HYBRID EVALUATION UNDER RHIZOMANIA, SALINAS, CA., 2000

36 entries x 8 replications, RCB
1-row plots, 22 ft. long

Planted: May 2, 2000
Harvested: October 23 & November 7, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Harv. Count No.	Beets/100' No.	RJAP %	Rhizomania Resistance DI	Rhizomania Resistance %R(0-4)
Checks									
Rizor	Spreckels,resist.ck,2-8-99	10726	29.96	17.92	37	169	84.7	3.14	93.2
Beta 4776R	Betaseed,resist.ck	12037	34.44	17.50	40	180	86.7	3.09	95.4
Beta 4430R	Betaseed,resist.ck,3-10-99	10147	28.59	17.80	41	160	85.6	2.87	95.2
US H11	1999 prod.,susc.ck,3-2-00	5435	19.10	14.02	35	178	84.1	5.77	4.3
Western Sugar entries									
Beta 4006R	rec'd 4-21-00	7931	22.89	17.25	27	110	84.3	3.35	87.8
Beta 4038R	rec'd 4-21-00	11455	32.48	17.66	40	180	84.4	2.88	97.0
HM 1639Rz	rec'd 4-21-00	10344	30.02	17.26	38	172	85.0	2.83	98.6
Kojak	rec'd 4-21-00	8404	25.56	16.41	36	167	85.4	4.04	54.3
Beta A940R	rec'd 4-21-00	9734	27.27	17.83	34	155	84.2	3.43	80.5
Beta A945R	rec'd 4-21-00	10670	28.99	18.38	39	168	85.1	3.21	89.5
Beta 4490R	rec'd 4-21-00	10351	28.67	18.08	41	172	84.5	3.01	96.3
Crystal 9906	rec'd 4-21-00	8697	24.79	17.58	35	160	85.0	3.12	89.0
Crystal 9941	rec'd 4-21-00	10232	28.69	17.79	37	158	85.7	3.20	89.3
HM1646Rz	rec'd 4-21-00	9675	26.01	18.52	36	160	84.2	3.14	89.1
HM1647Rz	rec'd 4-21-00	9474	26.66	17.79	35	166	85.9	3.02	96.6
Holly 00HX011	rec'd 4-21-00	10659	31.16	17.17	35	146	86.3	2.92	97.1
Holly 99HX975	rec'd 4-21-00	9772	28.20	17.38	31	147	83.7	3.08	92.9
SX0221	rec'd 4-21-00	9891	27.67	17.91	32	130	84.6	2.99	93.7
Beta 7CG9236LL	rec'd 4-11-00	10843	28.85	18.80	38	169	85.4	2.97	98.7
Beta 7KJ5109	rec'd 4-21-00	11475	31.82	17.99	39	176	85.9	3.08	96.8
Beta 7KJ5073	rec'd 4-21-00	10313	28.88	17.88	39	180	85.6	2.96	98.0
Monohikari	rec'd 4-21-00 (check)	5635	18.02	15.67	38	174	87.4	5.25	11.4
Beta 7CG9236RR	rec'd 4-11-00	9863	26.66	18.48	40	179	83.6	3.03	97.5

TEST 6600. WESTERN SUGAR, U of I, & USDA HYBRID EVALUATION UNDER RHIZOMANIA, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Harv. Count No.	Beets/ 100' No.	RJAP %	Rhizomania Resistance DI	Rhizomania Resistance %R(0-4)
Check									
US H11	1999 production	4642	15.81	14.66	37	170	83.4	5.35	7.3
University of Idaho									
Crystal 9908	rec'd 3-30-00	10456	29.09	18.01	36	165	84.4	3.32	87.0
Beta 8CG7299	rec'd 3-30-00	9630	26.89	17.92	32	168	82.8	3.05	95.4
HM125RzRR	rec'd 3-30-00	9577	28.37	16.86	36	165	85.4	3.17	86.7
HM2983Rz	rec'd 3-30-00	7782	23.46	16.60	33	151	84.9	3.97	60.6
HM2984Rz	rec'd 3-30-00	9938	29.42	16.86	36	139	85.3	3.59	74.3
HM2985Rz	rec'd 3-30-00	7186	21.44	16.81	31	129	84.2	4.10	58.2
SX1517	rec'd 3-30-00	7909	23.07	17.22	34	156	85.4	3.33	86.3
Beta 4035R	Idaho check	10099	30.48	16.61	37	161	86.1	3.23	85.7
HM2980	Idaho check	9119	26.01	17.61	35	151	84.7	3.08	93.8
Checks									
US H11	1999 production, susc. ck	4472	15.58	14.52	37	176	84.3	5.33	7.4
KW6770	Betaseed, susc. ck	6108	18.17	16.83	37	160	85.8	5.03	21.5
Monohikari	Seedex, 4-16-99, susc. ck	5701	17.94	15.86	35	163	87.3	5.49	7.2
Mean		9066.2	26.14	17.21	36.0	161.3	85.0	3.57	75.4
LSD (.05)		1489.3	4.29	0.72	5.4	15.4	1.9	0.37	12.0
C.V. (%)		16.7	16.64	4.25	10.8	9.7	2.2	7.38	11.3
F value		14.0**	9.74**	18.50**	2.5**	8.1**	2.4**	44.25**	55.2**

NOTES: See notes for test 6600-2.

TEST 6700. CBGA SALINAS CODED RHIZOMANIA TEST, SALINAS, CA., 2000

72 entries x 8 replications, RCB
1-row plots, 22 ft. long

Planted: May 2, 2000
Harvested: October 23 & , 2000

Code No.	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Harv. Count No.	Beets/ 100' No.	RJAP %	Rhizomania Resistance DI	Rhizomania Resistance %R(0-4)
CBGA entries										
1	Crystal 9922	Crystal	8957	27.64	16.20	35	155	84.8	4.09	53.6
2	Crystal 9921	Crystal	10022	30.47	16.39	36	152	84.7	3.26	84.5
3	Beta 4430R	Betaseed	11294	31.80	17.82	38	173	86.3	2.62	94.9
4	99HX983	Spreckels	7488	24.25	15.49	29	125	84.7	3.46	76.8
5	Beta 4300R	Betaseed	10632	30.54	17.41	39	164	86.2	3.32	82.2
6	98CX858	Spreckels	7815	24.37	16.11	36	153	84.3	3.72	73.4
7	8CG7164	Betaseed	12585	36.32	17.34	35	165	85.2	2.60	100.0
8	7CG7376	Betaseed	11562	32.31	17.92	40	181	86.2	2.78	99.4
9	99HX982	Spreckels	9247	26.21	17.61	36	156	86.0	3.40	83.4
10	99HX926	Spreckels	8312	25.61	16.17	35	159	84.4	3.22	89.5
11	99HX986	Spreckels	8822	27.00	16.33	38	170	84.7	3.39	80.8
12	99HX928	Spreckels	8503	26.93	15.74	37	155	83.3	3.33	80.4
13	8KG2705	Betaseed	8056	22.21	18.13	31	130	82.2	2.98	98.1
14	98HX853	Spreckels	9421	28.37	16.61	34	153	85.1	3.18	89.3
15	99HX981	Spreckels	9162	28.75	16.04	36	150	84.8	3.77	66.5
16	00HX010	Spreckels	10089	30.24	16.81	40	168	87.6	3.61	74.5
17	99HX923	Spreckels	7238	24.22	15.00	39	161	85.1	4.31	47.3
18	7KJ0146	Betaseed	11096	31.15	17.81	38	168	85.6	2.70	96.6
19	8CG7168	Betaseed	10802	32.93	16.44	36	170	87.7	2.75	96.7
20	8CG7172	Betaseed	11627	35.37	16.45	38	168	86.5	2.74	100.0
21	US H11	Standard	4458	15.46	14.48	39	176	84.2	5.61	3.3
22	7KJ0191	Betaseed	11356	31.34	18.11	40	169	85.5	2.86	98.8
23	Rodeo	Spreckels	8977	26.74	16.78	36	161	86.4	3.60	76.5
24	7CG7322	Betaseed	10271	30.23	16.93	36	165	84.8	2.90	96.1

TEST 6700. CBGA SALINAS CODED RHIZOMANIA TEST, SALINAS, CA., 2000

(cont.)

Code No.	Variety	Source	Acre Yield Sugar	Acre Yield Beets	Sucrose	Harv. Count	Beets/ 100'	RJAP	Rhizomania Resistance DI	Rhizomania Resistance %R(0-4)
			Lbs	Tons	%	No.	No.	%		
CBGA entries (cont.)										
25	99HX985	Spreckels	7198	20.58	17.54	30	137	84.4	3.21	91.7
26	Pinnacle	Spreckels	9101	28.14	16.18	37	157	85.2	3.53	76.3
27	99HX978	Spreckels	7184	20.96	17.23	34	138	85.6	3.23	88.7
28	99HX976	Spreckels	7882	24.40	16.17	30	135	85.4	3.65	73.2
29	98CX86	Spreckels	6448	20.22	15.91	33	149	84.2	4.17	51.1
30	7CG7410	Betaseed	9503	29.52	16.09	41	180	86.1	3.76	71.6
31	99HX987	Spreckels	8222	25.78	16.01	39	168	85.2	3.54	76.1
32	Phoenix	Spreckels	8792	24.98	17.62	34	142	85.6	3.13	90.8
33	00HX004	Spreckels	6650	21.34	15.66	35	162	84.2	4.11	55.7
34	99HX915	Spreckels	8265	23.79	17.35	38	161	88.4	3.96	58.7
35	Beta 4684R	Betaseed	9361	27.61	16.98	36	150	84.7	3.04	91.5
36	99HX917	Spreckels	6343	19.51	16.24	35	159	87.2	4.83	26.3
37	97CX14	Spreckels	8490	25.77	16.46	37	162	84.7	4.19	54.7
38	Summit	Spreckels	8693	26.66	16.34	35	161	85.1	3.69	71.1
39	99HX912	Spreckels	6960	20.82	16.68	37	160	85.1	4.89	27.0
40	Rifle	Spreckels	9753	29.12	16.85	31	148	86.4	3.11	84.8
41	8CG7171	Betaseed	9760	30.89	15.84	35	147	86.5	2.90	94.0
42	8CG7167	Betaseed	8962	27.33	16.42	39	168	87.3	2.88	96.0
43	99HX977	Spreckels	9919	28.67	17.31	36	151	84.0	3.03	93.7
44	99HX975	Spreckels	8998	25.77	17.45	32	148	83.4	3.34	82.7
45	Crystal 0024	Crystal	9915	25.79	19.23	38	167	85.7	4.26	47.7
46	Alpine	Spreckels	7354	21.71	16.96	33	142	83.7	3.70	69.5
47	99HX979	Spreckels	10762	30.22	17.84	36	158	83.7	2.95	92.1
48	Beta 4210R	Betaseed	10143	30.12	16.82	37	170	85.5	3.41	85.1
49	4KJ0164	Betaseed	9847	30.93	15.94	40	153	85.8	3.09	92.6
50	00HX006	Spreckels	7108	21.95	16.22	37	162	84.2	4.97	23.2
51	7KJ0197	Betaseed	10462	29.90	17.48	40	175	87.3	3.14	94.7
52	Crystal 9923	Crystal	8760	27.17	16.11	40	177	84.9	4.09	57.8
53	8KJ5137	Betaseed	10160	27.74	18.36	36	154	85.0	3.08	92.8

TEST 6700. CBGA SALINAS CODED RHIZOMANIA TEST, SALINAS, CA., 2000

(cont.)

Code No.	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Harv. Count No.	Beets/100' No.	RJAP %	Rhizomania Resistance DI	Rhizomania Resistance %R(0-4)
CBGA entries (cont.)										
54	Rival	Spreckels	9627	27.89	17.27	33	146	84.8	3.48	81.0
55	H93203	Spreckels	8207	25.56	16.13	37	156	85.3	3.63	71.8
56	00HX007	Spreckels	7972	23.66	16.89	39	169	84.8	4.19	56.0
57	Imperial	Spreckels	7150	21.44	16.71	35	161	84.9	3.82	63.2
58	6CG7492	Betaseed	11233	34.58	16.29	38	161	87.4	3.00	95.3
59	SS-781R	Spreckels	7326	22.66	16.29	34	147	84.4	3.54	75.4
60	Beta 4776R	Betaseed	10753	31.10	17.33	39	175	85.9	3.25	86.6
61	Beta 4035R	Betaseed	10075	29.32	17.17	38	165	85.1	3.05	93.0
62	Crystal 0025	Crystal	9621	24.82	19.41	35	168	85.3	4.30	47.9
63	5KJ5061	Betaseed	8073	24.40	16.56	29	117	84.1	3.24	90.2
64	8CG7165	Betaseed	9647	31.13	15.51	35	152	85.3	3.10	89.5
65	99HX924	Spreckels	7245	22.16	16.36	30	135	85.6	3.96	61.0
66	00HX003	Spreckels	8405	26.29	16.06	35	160	84.7	3.73	67.6
67	00HX001	Spreckels	7824	23.98	16.39	38	169	84.8	4.02	59.9
68	SS-432R	Spreckels	7262	22.35	16.36	34	149	83.5	4.13	58.2
69	SS-NB7R	Spreckels	7490	22.64	16.63	33	148	84.8	3.55	76.3
USDA entries										
70	Y969H5		10211	29.66	17.26	35	157	84.3	2.94	94.8
71	Y975H5		11320	33.89	16.69	36	157	83.6	2.74	98.0
72	US H11		4926	16.95	14.42	37	169	85.2	5.59	4.6
Mean			8932.7	26.70	16.71	35.8	157.6	85.2	3.53	75.3
LSD (.05)			1394.9	4.20	0.66	4.1	15.0	1.8	0.45	14.9
C.V. (%)			15.9	16.00	4.04	8.2	9.7	2.2	9.18	14.1
F value			10.3**	8.10**	14.42**	3.5**	5.6**	3.0**	15.98**	17.3**

TEST B100. EVALUATION OF TESTCROSS HYBRIDS, IMPERIAL VALLEY, 1999-2000

32 entries x 8 reps., RCB(E), 2 tiers per rep
1-row plots, 27 ft. long, 16 tiers, 16 rows

Planted: September 16, 1999
Harvested: May 16-17, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean
Checks								
Beta 4776R	4776.9002 (9-8-99)	10728	33.95	15.83	170	0.0	93.7	114
Beta 4430R	4430.9041 (9-8-99)	12325	36.68	16.83	169	0.0	93.3	75
Rifle	Spreckels 116240, 9-16-98	10637	33.07	16.12	156	1.7	93.6	96
Alpine	X612401, 9-10-99	10898	36.74	14.82	151	1.4	92.7	64
Multigerm, self-sterile lines								
Y969H50 (Sp)	C790-15CMS x Y869	11334	38.72	14.63	165	1.4	95.0	131
Y969H50 (Iso)	C790-15CMS x RZM-ER-% Y769	11178	36.23	15.44	156	3.0	94.0	94
R978H50	C790-15CMS x RZM-ER-% R778,%	11514	36.05	16.00	155	5.5	93.7	75
R980H50	C790-15CMS x RZM-ER-% R780/2,-45	11904	39.22	15.19	165	2.7	93.8	103
R970H50	C790-15CMS x RZM-ER-% R770	10832	35.00	15.52	167	3.0	93.0	117
R776-89-5H50	C790-15CMS x R576-89-5	10840	34.31	15.79	157	1.3	91.2	81
R976-89-18H50	C790-15CMS x R576-89-18	12051	38.85	15.57	162	3.7	95.8	104
R976-89-H50	C790-15CMS x R76-89-5/18	11608	35.41	16.46	158	0.3	94.6	58
Multigerm lines with *Bvm* germplasm								
Y975H50	C790-15CMS x RZM Y875	11023	37.34	14.78	165	1.1	94.0	92
Y967H50	C790-15CMS x RZM-ER-% Y767	11214	36.57	15.32	154	0.3	94.3	88
Y971H50	C790-15CMS x RZM-ER-% Y771	10232	34.28	14.94	160	3.6	93.2	97
P909H50	C790-15CMS x RZM-PMR P809,P810(C)	11077	35.85	15.39	159	11.1	87.6	113
R940H50	C790-15CMS x RZM-ER-% R740	10829	35.46	15.28	152	5.5	92.5	97
R954H50	C790-15CMS x RZM-ER-% R746,R954	10550	34.43	15.33	155	0.3	92.6	92
9934H50	C790-15CMS x RZM 8934(C)	11042	36.74	15.02	160	4.2	92.9	111
R936H50	C790-15CMS x RZM-ER-% R736	10107	34.04	14.82	162	3.7	92.4	137
Multigerm, self-fertile, Aa popns								
9931H50	C790-15CMS x RZM 8931	11337	37.69	15.06	155	3.2	93.4	98
9924H50	C790-15CMS x RZM 8924	11720	37.40	15.69	161	0.9	93.7	71
9932H50	C790-15CMS x RZM 8932	10075	33.62	14.98	161	4.5	91.9	72
9933H50	C790-15CMS x 8933	11758	37.87	15.45	159	4.0	92.8	83

TEST B100. EVALUATION OF TESTCROSS HYBRIDS, IMPERIAL VALLEY, 1999-2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean
Multigerm, self-fertile, Aa popns (cont.)								
Z925H50	C790-15CMS x RZM-ER-% Z725(C)	12366	40.03	15.42	156	9.1	92.3	101
CR911H50	C790-15CMS x CR811(C)	11301	37.42	15.14	160	3.7	93.1	93
CR909-1H50	C790-15CMS x RZM R709-1	11400	38.59	14.77	153	2.3	93.0	107
9926H50	C790-15CMS x RZM 8926	10495	34.12	15.39	161	4.8	93.2	92
9941H50	C790-15CMS x RZM 941(C)	11352	36.54	15.56	170	2.1	92.8	72
8935H50 (Sp)	C790-15CMS x R776-89-5H13	11018	35.59	15.56	160	5.7	94.0	90
8936H50	C790-15CMS x RZM R776-89-5H31	11835	36.74	16.21	162	1.3	92.4	65
8913-70H50	C790-15CMS x 6913-70	11089	36.97	15.05	163	5.8	94.4	69
Mean		11177.1	36.30	15.42	160.0	3.2	93.2	92.1
LSD (.05)		1223.3	3.74	0.69	12.0	3.6	3.4	36.9
C.V. (%)		11.1	10.47	4.53	7.6	114.0	3.7	40.7
F value		1.8*	1.75NS	4.31**	1.4NS	4.0**	1.2NS	
2.1NS								

NOTES: Test of multigerm breeding lines crossed to C790-15CMS. Y769 = C69. R778 ≈ C78. R780/2,-45 x C80. R576-89-5 = C76-89-5. R576-89-18 = C76-89-18. Y767 ≈ C67. R740 ≈ C79-#s. R746,R954,R736 ≈ C79-8. Z725 ≈ CZ25. CR811 ≈ CR09/10. 6913-70 = C913-70. P809,P810 have PMR from WB97 & WB242. 8931 = base MM,S^f,Aa,Rz population; 8924 has emphasis on VYR; 8932 on CTR; 8933 on root aphid resistance; Z725 on %S; CR811 on CR; R709-1 on CR; 8926 on rhizomania resistance from C51(*Bvm*); and 941,935, & 936 on combining VYR & *Rz*.

Test grown in area without known rhizomania. PM controlled with sulfur. No major disease or insect problems observed except for flea beetles at emergence. Late development of curly top was evident in some entries at harvest. Lettuce chlorosis was observed but incidence and severity were not known or determined.

Tests were grown on the Imperial Valley Research Center, Brawley, under the management of Clifford Brown. Technical assistance of Jeffrey Carrillo and Robert Betancourt is acknowledged.

TEST B300. EVALUATION OF EXPERIMENTAL HYBRIDS (POPN & S_1 PROG TESTCROSSES), IMPERIAL VALLEY, 1999-2000

32 entries x 8 reps., RCB(E), 2 tiers per rep
1-row plots, 27 ft. long, 16 tiers, 16 rows

Planted: September 16, 1999
Harvested: May 17, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Clean Beets %	NO3-N Mean
Checks								
Alpine	X612401, 9-10-99	11895	38.77	15.35	154	1.6	94.6	35
Phoenix	1392401, 9-10-99	11225	35.76	15.65	160	2.4	95.4	62
Beta 4430R	4430.9041 (9-8-99)	12349	39.57	15.62	170	0.0	93.9	42
Beta 4776R	4776.9002 (9-8-99)	10130	30.93	16.40	163	0.3	94.7	55
Popn & Line Hybrids & retest								
Y969H50 (Iso)	C790-15CMS x RZM-ER-% Y769	12072	39.39	15.32	153	3.3	95.1	49
Y975H50	C790-15CMS x RZM Y875	11213	36.65	15.31	162	2.1	94.3	51
9931H50	C790-15CMS x RZM 8931	11425	38.12	15.01	156	3.0	94.2	59
8929-114H50	C790-15CMS x 6929-114	11757	36.66	16.03	149	1.8	94.4	31
S_1 Progeny Hybrids								
9931-18H50	C790-15CMS x 7931-18	12017	37.65	15.89	161	11.8	93.3	47
9931-24H50	x 7931-24	10749	34.09	15.74	151	1.8	93.7	28
9931-29H50	x 7931-29	12415	39.79	15.64	155	5.8	93.2	23
9924-2H50	x 7924-2	11267	35.44	15.88	157	0.3	93.0	44
9924-6H50	C790-15CMS x 7924-6	11638	35.88	16.23	153	0.0	91.8	27
9924-10H50	x 7924-10	11304	37.60	15.02	165	7.0	92.6	52
9924-74H50	x 7924-74%	10798	34.16	15.80	164	15.9	93.9	36
9924-77H50	x 7924-77	11648	36.84	15.82	161	6.9	93.9	45
9924-78H50	C790-15CMS x 7924-78	10470	32.82	15.96	156	1.5	92.6	37
9924-114H50	x 7924-114VY	11027	34.20	16.11	155	9.5	93.8	37
9929-4H50	x 7929-4VY	12751	39.90	15.99	149	2.3	94.9	48
9929-9H50	x 7929-9VY	12048	38.92	15.51	158	7.9	94.1	37
9929-45H50	C790-15CMS x 7929-45VY	11271	34.98	16.12	154	4.2	94.7	33
9929-47H50	x 7929-47VY	12180	38.60	15.79	160	7.1	93.8	42
9929-48H50	x 7929-48VY	10814	36.34	14.90	153	0.0	94.2	44
9929-56H50	x 7929-56VY	10465	33.06	15.82	162	0.0	93.9	30

TEST B300. EVALUATION OF EXPERIMENTAL HYBRIDS (POPN & S_1 PROG TESTCROSSES), IMPERIAL VALLEY, 1999-2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Clean Beets %	NO3-N Mean
S_1 Progeny Hybrids (cont.)								
9929-62H50	C790-15CMS x 7929-62VY	13564	44.54	15.24	162	0.9	96.1	83
9930-17H50	x 7930-17VY	11478	36.35	15.84	158	1.1	94.5	31
9930-32H50	x 7930-32	11080	36.38	15.25	156	4.5	92.5	42
9930-35H50	x 7930-35	12497	37.22	16.79	157	0.6	94.7	27
9927-4H50	C790-15CMS x 7927-4VY	12973	40.43	16.02	167	2.5	92.8	39
9927-17H50	x 7927-17VY	11985	38.65	15.49	159	12.6	93.1	46
9928-34H50	x 7928-34	12216	41.30	14.78	158	0.8	94.7	87
9928-107H50	x 7928-107	11281	36.44	15.55	158	1.4	94.8	36
Mean		11625.1	37.11	15.68	157.9	3.8	94.0	43.4
LSD (.05)		1109.3	3.33	0.67	11.1	3.9	1.7	27.6
C.V. (%)		9.7	9.10	4.31	7.1	104.6	1.	64.5
F value		3.8**	5.31**	3.49**	1.6NS	8.7**	2.5**	2.2**

NOTES: See Tests B600, 3000, 6900 & 100. Self-fertile, multigerm, rhizomania resistant, genetic male-sterile-facilitated random-mated populations have been developed for population improvement. One improvement method involves S_1 progeny testing per se with subsequent testcross hybrid evaluation. In 1997, Individual S_o(Aa) plants from self-fertile populations were selfed under bags in the greenhouse. In 1998, S_1 progeny tests were run at Salinas, Davis, and Brawley. Based upon S_1 performance, 24 S_1 progeny were selected for hybrid performance tests. In 1999, these S_1 progeny were increased in isolation and crossed to a common monogerm, CMS tester. In 1999-2000, these increased lines and their experimental hybrids were evaluated at Brawley and Salinas for bolting tendency, disease reaction, and agronomic performance.

For the 1998 progeny tests, the S_1 lines were evaluated for sugar yield and concentration under virus yellows conditions (BYV-BWYV-BChV) at Salinas and Davis and under rhizomania at Salinas. The S_1 progeny were produced on plants from populations-931,-924,-929,-930,-927 and -928. Base popn-931 was used to develop the other popns. Popn-924 has a component from lines selected for VYR; popn-929 has a C31*Rz*-type component; popn-930 has a C78 component; popns-927 & -928 have germplasm from *Beta vulgaris* ssp. *maritima* through C51.

TEST B400. EVALUATION OF TOPCROSS HYBRIDS, IMPERIAL VALLEY, 1999-2000

16 entries x 8 reps., RCB(E), 2 tiers per rep
1-row plots, 27 ft. long, 16 tiers, 8 rows

Planted: September 16, 1999
Harvested: May 16, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Root Rot %	Clean Beets %	NO3-N Mean
Checks									
Beta 4776R	4776.9002 (9-8-99)	9350	30.79	15.27	158	0.0	0.0	93.7	206
R976-89H5	C833-5aa x R76-89-5/18	10035	32.39	15.56	151	0.0	0.0	90.0	146
Population Hybrids									
Y969H33	8833aa x Y869 (C69)	10179	35.07	14.62	145	4.2	0.3	96.2	210
Y969H35	8835aa x Y869	9035	32.30	13.99	156	0.6	0.0	95.6	187
Y969H69	C869aa x Y869	8646	30.75	14.17	154	0.6	0.0	95.9	223
Y969H48	8848aa x Y869	9317	32.65	14.37	144	0.6	0.0	94.8	200
Topcross Hybrids									
Y969H50(Sp)	C790-15CMS x Y869 (C69)	10281	37.07	13.93	150	0.6	0.0	94.7	224
Y969H3	97-C562HO x Y869	8523	31.75	13.47	152	0.3	0.0	91.7	226
Y969H37	4807HO (C306/2) x Y869	10290	37.85	13.74	147	0.3	0.0	94.9	277
Y969H45	C867-1HO x Y869	9174	33.31	13.88	148	0.9	0.3	95.1	204
Y969H46	7869-6HO x Y869	9438	34.94	13.51	150	0.3	0.0	95.0	228
Y969H5	C833-5aa x Y869	10113	34.21	14.83	143	0.3	0.9	94.9	190
Y969H12	C833-12aa x Y869	10293	33.99	15.10	137	0.3	0.3	96.6	184
Y969H4	C831-3aa x Y869	9729	33.43	14.51	140	0.0	0.0	95.7	176
Y969H27	C831-4HO x Y869	10844	39.40	13.78	146	0.0	0.0	95.1	227
Y969H29	C829-3aa x Y869	8583	31.35	13.80	154	0.0	0.0	94.5	240
Mean		9614.3	33.83	14.28	148.4	0.6	0.1	94.7	209.2
LSD (.05)		1090.3	3.64	1.07	10.2	1.0	0.5	3.7	53.2
C.V. (%)		11.5	10.86	7.60	6.9	177.8	447.1	4.0	25.7
F value		3.3**	3.80**	2.79*	2.7NS	7.8**	1.8*	1.6NS	2.5*

NOTES: R76-89-5/18 = mix of C76-89-5 & C76-89-18. See Test B500.

TEST B200. AREA 5 CODED MID-HARVEST YIELD TEST, IMPERIAL VALLEY, CA., 1999-2000

32 entries x 8 reps, RCB(E)
1-row plots, 27 ft. long

Planted: September 16, 1999
Harvested: June 5-6,2000

Code	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean
99M - 1	Beta 4684R	Betaseed	13431	42.30	15.89	162	0.5	94.8	96
- 2	Summit	Spreckels	13109	44.61	14.65	140	1.0	95.1	99
- 3	Phoenix	Spreckels	12433	40.48	15.30	159	0.3	95.3	122
- 4	8CG7165	Bestaseed	14420	51.46	13.98	163	0.0	93.7	159
- 5	99HX981	Spreckels	13769	50.27	13.72	163	0.0	94.6	139
- 6	99HX977	Spreckels	12005	37.59	15.93	149	1.7	95.0	106
- 7	8CG7171	Betaseed	13543	44.15	15.33	157	0.0	92.3	119
- 8	Beta 4776R	Betaseed	13031	42.60	15.29	168	0.3	93.2	123
- 9	Rifle	Spreckels	13292	41.92	15.85	161	2.0	94.8	100
-10	Beta 4035R	Betaseed	13385	43.07	15.53	166	1.9	94.1	110
-11	8CG7172	Betaseed	13643	46.85	14.59	162	0.0	93.6	180
-12	7CG7322	Betaseed	13004	44.10	14.77	155	3.5	94.8	156
-13	99HX976	Spreckels	12617	44.53	14.23	162	0.0	94.3	122
-14	99HX980	Spreckels	12154	40.28	15.03	162	1.2	94.8	113
-15	Pinnacle	Spreckels	11800	41.42	14.21	149	4.6	95.5	117
-16	8CG7164	Betaseed	15698	49.70	15.78	167	2.9	93.5	113
-17	7KJ0191	Betaseed	13706	41.85	16.35	163	0.0	93.6	98
-18	Beta 4430R	Betaseed	16075	49.48	16.22	170	0.0	92.9	72
-19	US H11	Standard	8457	33.01	12.79	154	0.6	92.5	66
-20	99HX975	Spreckels	14633	46.23	15.83	160	1.2	93.5	74
-21	99HX982	Spreckels	14035	46.78	14.98	148	5.3	95.5	118
-22	Beta 4210R	Betaseed	12746	48.05	13.32	148	0.0	95.1	214
-23	Alpine	Spreckels	12956	44.89	14.41	149	0.6	95.1	107
-24	99HX978	Spreckels	14985	50.56	14.86	159	0.3	95.9	129

TEST B200. AREA 5 CODED MID-HARVEST YIELD TEST, IMPERIAL VALLEY, CA., 1999-2000

(cont.)

Code	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Clean Beets %	NO3-N Mean
99M -25	99HX979	Spreckels	11819	40.26	14.70	153	0.3	94.6	172
-26	Imperial	Spreckels	11016	37.84	14.54	150	2.7	94.6	76
USDA entries									
	Variety	Description							
99M -27	Y969H6	C833-4H50 x C69	12309	43.78	14.07	157	0.9	94.3	103
-28	Y969H2	C831-3H50 x C69	12337	40.29	15.31	151	1.3	93.9	73
-29	Y939H27	C831-4CMS x C69	13407	47.87	14.04	153	0.3	94.8	95
-30	R976-89H6	C833-5H50 x C76-89-5/18	13143	42.61	15.41	161	0.6	94.9	66
-31	9941H6	C833-5H50 x 941	12068	38.79	15.57	150	0.7	93.7	66
-32	9931H6	C833-5H50 x 931	13753	45.86	15.03	150	0.0	92.7	68
Mean			13086.9	43.86	14.92	156.9	1.1	94.3	111.6
LSD (.05)			1522.1	4.91	0.62	12.9	1.8	1.5	35.0
C.V. (%)			11.8	11.37	4.24	8.3	169.0	1.6	31.8
F value			6.6**	5.82**	14.38**	2.5**	4.6**	3.1**	8.1**

NOTES: By harvest, in general test had pale, yellow cast and many leaves had interveinal chlorosis, then necrosis leading to scorched appearance. Off water two weeks. Cause of yellowing not known but late infection with curly top virus evident. Test may have had beet western yellows and/or lettuce chlorosis viruses. There were no obvious rhizomania symptoms but relative performance of USH11 suggested rhizomania might have been present. Powdery mildew controlled with sulfur. Mild *Empoasca* incidence. Mite not observed. No root rot.

For example, entries 3,6,11,12,14,21,22,24, and 25 were noted as having moderate to severe necrosis with entries 22 and 25 being most severe.

TEST B200. AREA 5 CODED MID-HARVEST YIELD TEST, IMPERIAL VALLEY, CA., 1999-2000

(cont.)

Code	Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH_2-N ppm	Impur. Value
99M - 1	Beta 4684R	11921	282	88.8	1510	396	2136	548	11935
- 2	Summit	11130	248	84.5	1979	457	2548	730	14906
- 3	Phoenix	10867	267	87.4	1566	497	2062	625	12830
- 4	8CG7165	12382	240	85.6	2039	467	2551	558	13317
- 5	99HX981	11652	232	84.7	2117	536	2678	574	14021
- 6	99HX977	10417	277	86.8	1587	496	2295	683	13962
- 7	8CG7171	11809	267	87.2	1734	458	2448	561	13049
- 8	Beta 4776R	11359	267	87.2	1673	490	2199	612	13024
- 9	Rifle	11696	279	88.1	1596	383	2252	590	12571
-10	Beta 4035R	11600	269	86.7	1785	468	2296	670	13738
-11	8CG7172	11698	250	85.8	1946	572	2542	569	13763
-12	7CG7322	11266	256	86.6	1738	480	2480	554	13142
-13	99HX976	10633	240	84.0	1983	512	2359	744	14754
-14	99HX980	10715	265	87.9	1439	420	2049	569	11999
-15	Pinnacle	10062	242	85.0	1738	571	2390	637	14030
-16	8CG7164	13751	277	87.5	1947	454	2227	616	13005
-17	7KJ0191	12104	289	88.2	1602	507	2107	604	12775
-18	Beta 4430R	14230	287	88.4	1845	404	2016	632	12453
-19	US H11	7313	221	86.2	1144	585	2459	359	11602
-20	99HX975	12813	277	87.6	1820	361	2169	674	13094
-21	99HX982	12231	261	86.9	1803	543	2522	495	12904
-22	Beta 4210R	10618	222	83.3	2128	697	2687	586	14726
-23	Alpine	11043	246	85.2	1913	484	2639	620	14179
-24	99HX978	13137	261	87.6	1848	447	2076	571	12183

TEST B200. AREA 5 CODED MID-HARVEST YIELD TEST, IMPERIAL VALLEY, CA., 1999-2000

(cont.)

Code	Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH_2-N ppm	Impur. Value
99M -25	99HX979	10267	255	86.9	1552	577	2326	525	12822
-26	Imperial	9467	250	85.8	1549	494	2401	623	13650
USDA entries									
-27	Y969H6	10770	246	87.2	1539	463	2158	496	11733
-28	Y969H2	10894	270	88.1	1442	418	2187	548	12135
-29	Y939H27	11248	236	84.1	2159	435	2798	658	14773
-30	R976-89H6	11671	273	88.6	1473	377	2114	535	11691
-31	9941H6	10617	274	87.9	1451	388	2233	582	12468
-32	9931H6	11823	259	85.8	1930	433	2448	670	14000
Mean		11350.2	259.0	86.6	1736.7	477.1	2339.1	594.3	13163.6
LSD (.05)		1376.9	14.2	2.0	304.5	103.5	312.1	134.9	1727.8
C.V. (%)		12.3	5.6	2.4	17.8	22.0	13.6	23.1	13.3
F value		6.5**	12.6**	4.1**	4.9**	3.9**	3.6**	2.4*	2.4*

TEST B500. EVALUATION OF EXPERIMENTAL HYBRIDS UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1999-2000

48 entries x 8 reps., RCB(E), 3 tiers per rep
1-row plots, 18 ft. long, 24 tiers, 16 rows

Planted: September 16, 1999
Harvested: May 18, 2000

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolters	Clean Beets	NO3-N
		Lbs	Tons	%	No.	%	%	Mean
Checks								
Phoenix	1392401, 9-10-99	10500	32.73	15.95	147	0.0	93.9	47
Alpine	X612401, 9-10-99	10343	34.11	15.23	140	0.0	93.5	83
Beta 4776R	4776.9002 (9-8-99)	8991	29.03	15.45	151	0.0	93.8	114
B4430R	4430.9041 (9-8-99)	11162	33.58	16.56	166	0.0	90.3	54
Topcrosses with C69: Monogerm lines								
Y969H50 (Sp)	C790-15CMS x Y869 (C69)	11111	37.66	14.66	154	0.0	94.6	91
Y969H37	4807HO (C306/2) x Y869	9148	35.48	12.92	148	0.0	93.6	98
Y969H6	C833-5H50 x Y869	10401	34.14	15.21	149	0.0	92.3	103
Y969H5	C833-5aa x Y869	11240	36.10	15.58	137	0.0	93.8	58
Y969H29	C829-3aa x Y869	10538	35.37	14.89	150	0.0	94.3	147
Y969H4	C831-3aa x Y869	10739	34.97	15.44	131	0.0	93.6	42
Y969H27	C831-4HO x Y869	10284	36.14	14.23	151	0.0	94.1	67
Y969H12	C833-12aa x Y869	10781	36.71	14.68	145	0.0	95.7	86
Monogerm populations								
Y969H53	8833H50 x Y869	9300	32.87	14.28	151	0.4	92.4	117
Y969H35	8835aa x Y869	10379	36.93	14.01	156	0.0	95.1	182
Y969H38	8838aa x Y869	9148	31.81	14.40	147	0.0	93.8	126
Y969H69	C869aa x Y869	9128	33.46	13.69	152	0.4	95.1	110
Y969H10	8810aa x Y869	9222	30.85	14.97	144	0.0	93.8	126
Y969H48	8848aa x Y869	10020	34.48	14.41	140	0.5	92.6	123
Y969H56	8836HO x Y869	9497	32.42	14.53	141	0.0	92.5	84
Topcrosses with Y75 (*Bvm* germplasm)								
Y975H50	C790-15CMS x Y875	11525	37.15	15.48	148	0.8	94.4	75
Y975H5	C833-5aa x Y875	10819	34.78	15.53	140	0.0	94.0	73

TEST B500. EVALUATION OF EXPERIMENTAL HYBRIDS UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1999-2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Clean Beets %	NO3-N Mean
Topcrosses with Y75 (*Bvm* germplasm) (cont.)								
Y975H6	C833-5H50 x Y875	10258	34.03	14.99	152	0.0	91.9	92
Y975H2	C831-3H50 x Y875	10750	36.62	14.72	153	0.0	92.6	104
Y975H27	C831-4HO x Y875	10900	37.82	14.38	146	0.0	93.2	103
Y975H13	C833-12H50 x Y875	10890	35.71	15.19	141	0.0	94.5	81
Y975H30	C829-3H50 x Y875	10256	34.08	14.99	154	1.0	93.6	78
Y975H35	8835aa x Y875	10202	35.37	14.44	154	0.0	95.2	98
Y975H10	8810aa x Y875	10223	33.65	15.20	141	0.5	94.0	127
Topcrosses with R76-89								
R976-89H50	C790-15CMS x R76-89-5/18	10376	33.54	15.52	158	0.0	93.8	61
R976-89H5	C833-5aa x R76-89-5/18	9796	30.79	15.89	146	0.0	92.8	92
Topcrosses with popn-931								
9931H50	C790-15CMS x RZM 8931	10560	34.82	15.20	154	0.0	92.2	99
9931H5	C833-5aa x RZM 8931	11679	36.92	15.90	143	0.0	92.6	90
9931H6	C833-5H50 x RZM 8931	11113	37.10	15.00	145	0.0	92.9	114
9931H2	C831-3H50 x RZM 8931	10767	34.50	15.61	159	0.4	92.2	61
9931H27	C831-4HO x RZM 8931	10313	36.38	14.19	143	0.0	93.6	158
9931H35	8835aa x RZM 8931	10039	34.11	14.71	158	0.0	93.1	85
Topcrosses with popn-926 (*Bvm* germplasm)								
9926H50	C790-15CMS x 8926	10738	34.19	15.72	153	0.0	92.1	38
9926H6	C833-5H50 x 8926	10550	33.11	15.94	159	1.4	92.3	55
9926H35	8835aa x 8926	11232	37.53	14.88	156	0.0	94.0	61
9926H48	8848aa x 8926	10902	35.65	15.23	140	0.4	92.0	78
Topcrosses with popn-CR11								
CR911H50	C790-15CMS x CR811(C)	9838	32.33	15.20	139	0.0	91.7	71
CR911H35	8835aa x CR811(C)	9486	32.53	14.52	143	1.0	93.7	71

TEST B500. EVALUATION OF EXPERIMENTAL HYBRIDS UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1999-2000

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolters	Clean Beets	NO3-N
		Lbs	Tons	%	No.	%	%	Mean
Topcrosses with popn-933								
9933H50	C790-15CMS x 8933	9941	32.19	15.40	148	1.4	92.2	63
9933H35	8835aa x 8933	10732	33.80	15.76	157	2.7	93.7	44
Topcrosses with popn-941								
9941H50	C790-15CMS x 941(C)	9736	32.20	15.14	147	1.8	92.8	83
9941H5	C833-5aa x 941(C)	10032	32.56	15.45	132	0.5	90.0	87
9941H6	C833-5H50 x 941(C)	10170	33.32	15.14	146	0.0	90.6	123
9941H35	8835aa x 941(C)	10053	34.43	14.52	153	0.0	91.6	141
Mean		10329.4	34.38	15.02	148.1	0.3	93.2	90.9
LSD (.05)		1441.2	4.45	0.94	13.8	1.0	2.5	73.5
C.V. (%)		14.2	13.13	6.32	9.5	352.6	2.7	82.1
F value		1.6NS	1.54NS	3.92**	2.2*	2.6**	1.9**	1.4NS

NOTES: Stands were variable due to damage by flea beetles and erratic emergence. See notes for B600.
C833-5H50 = C790-15CMS x C833-5. HO = CMS. Aa = genetic male sterility.

TEST B600. EVALUATION OF TESTCROSS HYBRIDS UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1999-2000

48 entries x 8 reps., RCB(E), 3 tiers per rep
1-row plots, 18 ft. long, 24 tiers, 16 rows

Planted: September 16, 1999
Harvested: May 19, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Root Rot %	Clean Beets %	NO3-N Mean
Checks									
Alpine	X612401, 9-10-99	11134	35.54	15.69	151	0.9	0.0	92.7	49
Phoenix	1392401, 9-10-99	11496	33.93	16.94	158	0.0	0.0	95.2	46
B4776R	4776.9002 (9-8-99)	9625	28.82	16.73	159	1.0	0.0	94.2	41
7CG7322	9-13-99	10221	31.85	16.20	149	1.8	0.0	91.7	31
Retest from B399 & B899									
9918-21H50	C790-15CMS x RZM 8918-21	11448	35.26	16.25	146	0.0	0.0	92.8	17
8929-41H50	C790-15CMS x 6929-41	10519	32.09	16.39	147	0.0	0.0	90.1	22
8930-19H50	C790-15CMS x 6930-19	11382	33.37	17.12	159	0.0	0.0	92.2	24
8927-30H50	C790-15CMS x 6927-30	9971	30.32	16.45	152	0.0	0.0	90.2	29
Hybrids with *Bvm*, R22, C51 resistance									
P911H50	C790-15CMS x RZM-PMR P811	11221	36.45	15.45	147	14.1	0.0	93.8	45
P909H50	C790-15CMS x RZM-PMR P809,10(C)	12419	39.81	15.59	156	4.0	0.0	92.9	47
P912H50	C790-15CMS x PM-RZM P812	10581	33.93	15.65	150	0.4	0.0	92.5	38
9934H50	C790-15CMS x RZM 8934(C)	9773	30.58	16.06	158	4.5	0.0	89.9	38
Y967H50	C790-15CMS x RZM-ER-% Y767	11183	34.79	16.10	149	0.5	0.0	93.2	53
Y971H50	C790-15CMS x RZM-ER-% Y771	10465	33.00	15.89	145	0.5	0.0	90.6	36
R940H50	C790-15CMS x RZM-ER-% R740	10619	32.70	16.27	148	5.9	0.0	93.2	41
R936H50	C790-15CMS x RZM-ER-% R736	10458	32.57	16.07	151	5.0	0.0	91.7	49
R954H50	C790-15CMS x RZM-ER-% R754,R746	10227	32.29	15.86	154	0.0	0.0	92.3	27
R943H50	C790-15CMS x RZM-ER-% R643	11436	33.97	16.85	149	16.4	0.0	94.2	24
9926H50	C790-15CMS x 8926	9915	30.75	16.13	154	2.7	0.0	90.8	39
9927-4H50	C790-15CMS x 7927-4VY	11890	35.92	16.55	150	0.5	0.0	91.1	26

TEST B600. EVALUATION OF TESTCROSS HYBRIDS UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1999-2000

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolters	Root Rot	Clean Beets	NO3-N
		Lbs	Tons	%	No.	%	%	%	Mean
Hybrids with *Bvm*, R22, C51 resistance (cont.)									
9927-17H50	C790-15CMS x 7927-17VY	10810	33.82	15.97	157	5.2	0.0	91.6	24
9928-34H50	C790-15CMS x 7928-34	11621	35.76	16.30	150	0.0	0.0	91.7	27
9928-107H50	C790-15CMS x 7928-107	11069	33.52	16.50	150	0.0	0.4	92.2	18
Hybrids with popn-931 progenies									
9931H50	C790-15CMS x RZM 8931	10687	33.50	15.98	147	1.3	0.0	90.6	31
Z925H50	C790-15CMS x RZM-ER-% Z725(C)	11888	35.97	16.54	147	9.5	0.5	93.2	19
9931-18H50	C790-15CMS x 7931-18	10827	31.38	17.24	155	9.6	0.0	90.9	23
9931-24H50	C790-15CMS x 7931-24	10614	31.47	16.88	146	0.4	0.5	89.8	18
9931-29H50	C790-15CMS x 7931-29	11676	35.46	16.44	146	0.5	0.0	92.2	21
Hybrids with popn-924 progenies									
9924H50	C790-15CMS x 8924	11536	34.99	16.48	151	1.4	0.0	92.2	24
9924-2H50	C790-15CMS x 7924-2	10391	31.25	16.66	151	0.0	0.0	90.3	28
9924-6H50	C790-15CMS x 7924-6	10619	30.95	17.21	157	0.0	0.5	86.9	20
9924-10H50	C790-15CMS x 7924-10	10997	33.98	16.25	150	7.7	0.0	93.5	23
9924-74H50	C790-15CMS x 7924-74%	10502	32.47	16.19	157	3.3	0.0	93.3	14
9924-77H50	C790-15CMS x 7924-77	11163	32.67	17.08	151	4.1	0.0	91.7	27
9924-78H50	C790-15CMS x 7924-78	9507	28.37	16.83	153	0.0	0.0	89.6	22
9924-114H50	C790-15CMS x 7924-114VY	9814	28.85	17.08	146	5.6	0.0	92.8	9
Hybrids with popn-929 progenies									
R976-89-18H50	C790-15CMS x R576-89-18,NB	12221	37.30	16.38	154	1.3	0.0	94.6	18
9929-4H50	C790-15CMS x 7929-4VY	11249	33.86	16.69	143	1.3	0.0	92.9	15
9929-9H50	C790-15CMS x 7929-9VY	11807	34.55	17.08	153	6.8	0.0	92.9	13
9929-45H50	C790-15CMS x 7929-45VY	11083	32.40	17.13	151	3.9	0.0	93.0	15

TEST B600. EVALUATION OF TESTCROSS HYBRIDS UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1999-2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Root Rot %	Clean Beets %	NO3-N Mean
Hybrids with popn-929 progenies (cont.)									
9929-47H50	C790-15CMS x 7924-47VY	11075	34.32	16.19	150	2.3	0.4	92.9	22
9929-48H50	C790-15CMS x 7929-48VY	10862	34.45	15.78	154	0.0	0.0	91.3	15
9929-56H50	C790-15CMS x 7929-56VY	9956	29.99	16.65	148	0.0	0.0	91.2	16
9929-62H50	C790-15CMS x 7929-62VY	13761	41.40	16.68	157	0.0	0.0	94.9	24
Hybrids with popn-930 progenies									
R978H50	C790-15CMS x RZM-ER-% R778,%	11532	34.63	16.73	144	1.5	0.0	92.8	28
9930-17H50	C790-15CMS x 7930-17VY	11019	32.94	16.70	149	0.0	0.0	91.9	16
9930-32H50	C790-15CMS x 7930-32	10062	32.24	15.60	145	0.5	0.0	90.6	17
9930-35H50	C790-15CMS x 7930-35	11197	31.24	17.92	157	0.0	0.0	91.8	17
Mean		10948.5	33.37	16.45	151.0	2.6	0.1	92.1	26.6
LSD (.05)		1203.4	3.61	0.72	10.2	3.4	0.4	2.3	25.8
C.V. (%)		11.2	10.99	4.46	6.8	133.4	879.5	2.5	98.2
F value		3.5**	3.90**	4.03**	1.4NS	9.4**	0.9NS	3.6**	1.5NS

NOTES: See notes for B300. In addition to entries in Test B300, other checks and experimental hybrids were included. Hybrids involving S_1 lines 6929-41, 6930-19, and 6927-30 were retested based upon 1999 results at Brawley. P811, P809, P810, and P812 involve germplasm from WB97 and WB242 for resistance to powdery mildew (PMR). Lines Y767 (~C67), Y771, R740(~C79-#s), R736(~C79-8), R754, R643, 8926, and 8934 have germplasm from *B.v.*ssp *maritima*. 8931 = popn-931. Z725 = popn-Z725 ≈ CZ25. 8924 = popn-924. R576-89-18 = C76-89-18. R778 ≈ C78.

Rhizomania to this point in season appeared to be mild. Root symptoms were very minimal. Light yellow foliar symptoms ("blinkers"), however, were obvious throughout Field K tests. Late development of curly top was evident in some entries (e.g., Beta 4776R and Phoenix).

TEST B700. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES UNDER RHIZOMANIA, IMPERIAL VALLEY, 1999-2000

72 entries x 4 reps., RCB
1-row plots, 18 ft. long

Planted: September 17, 1999
Harvested: June 6-7, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Root Rot %	Clean Beets %	Appearance Score 5/17	NO3-N Mean
Checks										
B4776R	4776.9002 (9-8-99)	9464	29.33	16.24	150	0.0	0.9	92.1	3.8	38
7CG7322	9-13-99	9061	29.32	15.46	149	2.8	0.9	92.5	3.0	75
Alpine	X612401, 9-10-99	10052	32.78	15.52	147	0.9	0.0	94.8	2.8	50
Phoenix	1392401, 9-10-99	11105	34.33	16.20	165	0.0	0.0	94.8	3.3	58
B4430R	4430.9041, 9-8-99	11238	33.65	16.72	167	0.0	1.5	92.3	3.0	41
Rifle	Spreckels, 9-98 L1162401	9349	28.39	16.33	162	0.0	0.0	93.0	3.0	25
Y969H50(Sp)	C790-15CMS x Y869	8397	29.73	13.94	149	0.0	2.9	93.4	3.3	53
Y969H48	8848aa x Y869	9674	30.76	15.63	149	2.8	0.0	93.6	2.8	46
S_1 progenies from popn-835										
Y969H35	8835aa x Y869	8513	28.31	14.98	154	0.0	1.7	93.9	3.0	51
Y969H35 - 1	8835 - 1aa x Y869	10401	32.42	15.88	151	0.0	0.9	95.6	2.5	43
Y969H35 - 2	8835 - 2aa	8774	30.33	14.35	153	0.0	4.0	93.9	3.0	29
Y969H35 - 3	8835 - 3aa	9747	31.15	15.45	136	0.0	1.0	91.9	2.8	34
Y969H35 - 4	8835 - 4aa x Y869	9517	31.04	15.43	142	0.0	3.9	93.7	2.5	24
- 6	- 6aa	12490	42.10	14.86	149	0.0	1.9	94.7	2.3	58
- 7	- 7aa	7038	24.19	14.44	147	0.0	6.9	94.9	4.0	27
- 8	- 8aa	7144	25.20	14.07	138	0.0	2.1	94.3	3.8	42
Y969H35 - 9	8835 - 9aa x Y869	10453	33.69	15.68	146	0.0	0.0	92.7	2.3	39
-10	-10aa	8815	28.80	15.33	154	0.0	2.6	91.9	2.8	32
-11	-11aa	10239	33.67	15.37	147	0.0	0.9	94.2	2.3	65
-12	-12aa	9682	29.39	16.40	140	0.0	1.1	92.6	3.3	25
-13	-13aa	9199	30.51	14.77	153	8.2	0.9	94.1	3.8	33
-14	-14aa	8810	28.70	15.06	130	0.0	3.5	93.6	3.3	41

TEST B700. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES UNDER RHIZOMANIA, IMPERIAL VALLEY, 1999-2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Root Rot %	Clean Beets %	Appearance Score 5/17	NO3-N Mean
S_1 progenies from popn-835 (cont.)										
Y969H35 -16	8835 -16aa x Y869	9595	31.79	15.05	157	0.8	0.0	93.6	3.0	23
-17	-17aa	9093	28.47	15.80	152	2.8	2.0	94.7	3.3	30
Y969H35 -18	8835 -18aa x Y869	10483	34.22	15.14	145	0.0	4.9	95.1	2.8	27
-22	-22aa	8361	27.51	15.32	145	0.0	2.0	93.4	3.0	33
-24	-24aa	9035	29.30	15.53	152	0.0	3.1	94.1	3.0	29
-25	-25aa	9896	33.30	14.85	149	0.0	3.3	94.3	3.0	33
Y969H35 -26	8835 -26aa x Y869	10624	33.02	16.11	136	0.0	0.0	94.7	3.5	23
-28	-28aa	7549	24.93	15.02	155	0.0	2.7	93.8	3.3	21
-31	-31aa	9508	31.03	15.36	152	0.0	6.5	94.8	3.8	34
-32	-32aa	8892	26.81	16.53	149	0.0	0.0	93.1	2.8	21
Y969H35 -33	8835 -33aa x Y869	8770	29.55	14.87	160	2.6	0.0	94.5	3.5	28
-33B	-33Baa	8741	26.67	16.31	145	2.7	3.1	94.2	3.5	24
-35	-35aa	9061	29.99	15.14	163	0.0	0.0	93.2	2.3	25
-41	-41aa	10854	33.07	16.37	151	0.0	0.0	93.6	2.8	41
Y969H35 -42	8835 -42aa x Y869	8213	28.81	14.35	142	0.0	2.9	92.9	3.0	22
-43	-43aa	8348	25.79	16.24	128	0.0	1.0	91.3	3.5	22
-45	-45aa	8766	27.21	16.15	162	0.0	0.0	92.0	3.8	18
-47	-47aa	8369	28.30	14.95	144	0.0	4.1	94.0	4.0	27
Y969H35 -48	8835 -48aa x Y869	9571	31.06	15.31	156	0.9	0.9	93.4	3.5	39
-53	-53aa	9137	28.00	16.32	146	0.0	0.0	94.1	3.3	27
-54	-54aa	10998	34.26	15.88	156	1.8	0.0	94.5	2.8	23
-61	-61aa	9858	30.62	15.97	144	0.0	1.9	92.4	3.0	23
Y969H35 -74	8835 -74aa x Y869	7104	22.91	15.33	145	0.0	1.9	93.6	3.5	39
-75	-75aa	10061	32.07	15.68	147	0.0	0.9	94.6	2.5	51
-79	-79aa	7785	25.04	15.74	146	1.9	0.0	92.8	3.0	34
-80	-80aa	9422	30.86	15.13	154	1.9	0.9	93.4	2.5	43

TEST B700. HYBRID PERFORMANCE OF MONOGERM S_1 PROGENY LINES UNDER RHIZOMANIA, IMPERIAL VALLEY, 1999-2000 (cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Root Rot %	Clean Beets %	Appearance Score 5/17	NO3-N Mean
S_1 progenies from popn-835 (cont.)										
Y969H35 -81	8835 -81aa x Y869	7890	26.68	14.88	143	0.0	0.9	94.1	3.5	41
-82	-82aa	9554	30.00	15.81	156	0.0	2.7	92.1	2.8	27
-85	-85aa	8234	25.86	15.86	156	0.0	0.9	93.5	3.8	20
-87	-87aa	9219	29.66	15.76	146	0.0	0.9	93.3	3.0	71
S_1 progenies from line C833-5										
Y969H6	8833 -5H50 x Y869	9504	30.06	15.94	155	0.0	3.6	93.3	3.3	62
Y969H5	8833 -5aa x Y869	8824	25.81	17.05	147	0.0	1.8	92.1	3.3	26
Y969H5 -52	8833 -5-2aa x Y869	10369	31.75	16.32	151	0.0	0.0	93.0	3.0	42
-53	-5-3aa x Y869	10266	30.72	16.70	152	0.0	0.9	92.3	2.8	28
Y969H5 -56	8833 -5-6aa x Y869	8913	28.55	15.57	149	0.0	0.9	93.4	3.0	28
-57	-5-7aa	9902	29.24	16.92	144	0.0	1.0	93.1	2.8	30
-58	-5-8aa	10832	33.20	16.27	151	0.0	0.0	94.4	2.8	37
-59	-5-9aa	9341	27.69	16.85	137	0.0	1.9	92.1	2.5	27
Y969H5 -510	8833 -5-10aa x Y869	11479	34.42	16.69	145	0.0	0.0	92.3	2.8	20
-511	-5-11aa	10617	31.05	17.10	139	0.0	0.0	93.7	2.8	27
-512	-5-12aa	8720	26.30	16.47	146	0.0	1.7	93.2	3.0	38
-513	-5-13aa	9835	28.85	17.02	151	0.0	0.0	92.0	3.0	22
Y969H5 -515	8833 -5-15aa x Y869	8802	27.86	15.73	147	0.0	6.6	93.9	3.5	19
-517	-5-17aa	11546	34.46	16.61	152	0.0	0.8	93.0	2.5	19
-518	-5-18aa	9038	28.06	16.03	143	0.0	0.0	93.2	3.5	36
-519	-5-19aa	10132	33.70	15.06	141	0.0	0.0	91.6	2.8	45
-521	-5-21aa	10225	31.26	16.32	153	0.0	0.0	93.2	3.3	30
Y969H12 -122	8833 -12-2aa x Y869	10601	32.04	16.45	152	0.0	0.0	94.9	2.8	18
-124	-12-4aa x Y869	10992	35.73	15.39	147	0.0	0.0	94.4	2.5	30
-127	-12-7aa x Y869	10074	32.56	15.51	151	0.0	0.0	95.3	2.5	36
Mean		9474.5	30.11	15.71	148.8	0.4	1.5	93.5	3.0	34.1
LSD (.05)		3682.1	11.11	1.36	20.9	1.8	4.5	2.0	1.1	43.8
C.V. (%)		27.9	26.47	6.20	10.1	309.6	224.2	1.5	26.4	92.1
F value		0.7NS	0.6NS	2.29**	0.9NS	3.5**	1.1NS	1.9**	1.2NS	0.7NS

TEST B800. HYBRID PERFORMANCE OF MONOGERM S_2 PROGENY LINES UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1999-2000

36 entries x 4 reps., RCB
1-row plots, 18 ft. long

Planted: September 17, 1999
Harvested: June 8, 2000

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Root Rot	Clean Beets	Appearance Score		NO3-N
		Lbs	Tons	%	No.	%	%	5/17	6/06	Mean
Checks										
Alpine	X612401, 9-10-99	8103	27.07	14.89	134	4.9	93.1	2.5	3.3	51
B4776R	4776.9002, 9-8-99	7238	22.64	16.06	152	5.2	93.4	3.5	3.3	47
Y969H50	C790-15CMS x Y869	6957	23.64	14.82	151	2.7	93.5	3.5	3.3	44
Y969H10	8810mmaa x Y869	6740	21.80	15.53	147	5.4	93.8	3.5	3.5	17
Y969H48	8848aa x Y869	8456	28.47	14.92	155	1.8	93.7	2.5	3.0	43
S_2 progeny topcrosses										
Y969H9 - 24	8808 - 2-4aa x Y869	6349	21.02	15.08	151	6.6	93.6	3.8	3.5	26
- 25	- 2-5aa	6765	23.94	14.10	154	0.9	93.6	2.8	3.3	31
- 26	- 2-6aa	6947	24.43	14.43	147	7.7	94.3	3.3	3.5	38
Y969H9 - 31	8808 - 3-1aa	7233	23.95	15.05	134	4.2	93.7	3.3	3.0	27
- 32	- 3-2aa	6885	22.14	15.50	153	2.5	93.7	3.5	3.0	30
- 33	- 3-3aa	8227	27.19	15.01	125	2.4	94.3	3.0	3.0	27
- 35	- 3-5aa	5800	18.41	15.68	141	10.7	94.0	4.3	3.8	17
- 36	- 3-6aa x Y869	6604	21.46	15.19	143	8.4	94.4	4.0	3.5	25
Y969H9 - 41	8808 - 4-1aa x Y869	5861	19.74	14.77	139	8.6	94.7	3.5	3.5	43
- 42	- 4-2aa	6150	20.35	14.93	154	8.4	94.1	3.8	4.0	26
- 45	- 4-5aa	7118	24.56	14.35	153	0.9	95.0	3.8	4.0	18
- 46	- 4-6aa x Y869	8230	26.81	15.29	146	3.4	93.1	3.8	3.8	19
- 47	- 4-7aa x Y869	5770	17.99	15.93	140	2.0	93.8	4.0	4.0	20
Y969H9 - 72	8808 - 7-2aa x Y869	7950	24.80	15.92	151	5.8	93.2	3.3	3.3	25
- 74	- 7-4aa x Y869	6549	20.80	15.39	141	13.3	93.2	3.0	3.5	25
Y969H9 - 85	8808 - 8-5aa x Y869	5432	19.48	13.90	144	9.4	94.7	4.0	4.0	39

TEST B800. HYBRID PERFORMANCE OF MONOGERM S_2 PROGENY LINES UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1999-2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	Clean Beets %	Appearance Score 5/17	Appearance Score 6/06	NO3-N Mean
S_2 progeny topcrosses (cont.)										
Y969H9 - 92	8808 - 9-2aa x Y869	6594	21.66	15.12	159	5.4	94.1	3.5	4.0	25
- 93	- 9-3aa x Y869	7436	24.13	15.48	141	6.0	94.1	3.5	3.5	40
- 94	- 9-4aa x Y869	5007	16.35	15.65	144	4.7	94.0	3.5	3.5	31
- 96	8808 - 9-6aa x Y869	7723	26.76	14.50	152	3.3	94.9	3.3	3.8	27
- 97	- 9-7aa x Y869	6591	21.53	15.14	146	7.0	93.8	3.3	3.3	32
-913	- 9-13aa x Y869	6053	18.63	16.16	150	3.3	93.2	3.3	3.5	24
Y969H9 -121	8808 -12-1aa x Y869	7637	25.70	14.90	162	12.1	95.5	3.0	4.0	31
-123	-12-3aa x Y869	6626	22.16	14.94	145	2.8	95.0	3.8	3.8	24
-124	-12-4aa x Y869	7905	25.59	15.40	155	2.7	95.3	3.8	3.5	25
-125	-12-5aa x Y869	8406	27.40	15.35	145	1.1	95.1	3.0	3.0	24
-126	-12-6aa x Y869	7849	25.09	15.10	148	8.8	95.7	3.5	3.5	15
Y969H9 -131	8808 -13-1aa x Y869	6830	21.50	15.65	145	6.3	94.8	3.8	3.8	36
-132	-13-2aa x Y869	6891	22.93	15.01	151	1.8	94.6	3.5	3.8	36
Y969H9 -166	8808 -16-6aa x Y869	6018	20.32	14.71	141	4.8	94.7	3.8	3.8	21
-167	-16-7aa x Y869	4811	15.63	14.90	138	8.6	93.3	4.5	4.0	42
Mean		6881.6	22.67	15.13	146.6	5.4	94.1	3.5	3.5	29.7
LSD (.05)		3012.0	9.80	1.35	21.6	10.1	2.3	1.2	1.0	33.5
C.V. (%)		31.2	30.84	6.36	10.5	134.3	1.7	24.8	20.3	80.6
F value		0.8NS	0.8NS	1.17NS	1.0NS	0.8NS	0.8NS	1.0NS	0.8NS	
0.6NS										

NOTES: See notes for B900. Popns-8848, 8810, and 8808 are monogerm,S^f,A:aa similar to C790 but with a germplasm contribution from *Beta vulgaris* ssp. *maritima* through C51(R22). Multigerm tester Y869 ≈ C69.

TEST B900. FULL-SIB AND S_1 PROGENY PERFORMANCE UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1999-2000

72 entries x 2 reps., RCB
1-row plots, 18 ft. long

Planted: September 17, 1999
Harvested: June 7, 2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/100' No.	Bolters %	Root Rot %	Clean Beets %	Appearance Score 5/17	Appearance Score 6/06	NO3-N Mean
Checks											
B4776R	4776.9002,9-8-99	4566	17.32	13.99	153	0.0	3.6	93.4	4.0	4.0	120
Y967	RZM-ER-% Y767 (Iso)	8798	30.05	14.80	157	0.0	1.7	94.9	2.0	1.5	85
Y971	RZM-ER-% Y771 (Iso)	9370	32.68	14.38	144	0.0	0.0	95.7	1.0	1.5	84
9934	RZM 8934(C), [C76-89-5 x (C913-70 x R36)]	6951	23.64	14.70	157	4.0	3.3	92.9	3.0	3.0	16
FS's from Y67 (C67)											
Y967 - 1	RZM Y867 PX	9117	31.95	14.25	142	0.0	0.0	94.3	1.5	2.5	43
- 2		7878	27.17	14.72	139	0.0	0.0	93.1	2.0	2.0	46
- 3		10772	33.53	16.08	142	0.0	0.0	94.9	1.5	1.5	30
- 4		8411	25.26	16.65	142	0.0	0.0	94.0	2.0	2.5	16
- 5		9640	30.37	15.90	119	0.0	0.0	93.0	2.0	2.0	18
- 6		7109	22.16	16.00	149	11.5	0.0	89.3	3.5	3.0	18
- 7		8034	24.45	16.41	149	0.0	0.0	93.9	3.0	3.0	16
- 8		8576	26.12	16.41	128	0.0	0.0	94.7	2.5	2.5	18
- 9		10730	33.95	15.87	153	0.0	0.0	96.6	2.0	1.5	23
-10		9816	30.05	16.35	138	0.0	0.0	94.9	2.5	3.0	19
FS's from Y72 (C72)											
Y972 - 1	RZM Y872 PX	9873	31.18	15.85	144	0.0	0.0	89.2	1.5	1.5	22
- 2		9387	32.12	14.76	139	0.0	1.9	93.8	2.0	2.5	24
- 3		8761	28.08	15.60	146	0.0	0.0	95.0	2.5	3.5	27
- 4		8714	28.15	15.42	149	0.0	0.0	89.8	2.0	3.0	18
- 5		8401	26.29	16.13	151	0.0	0.0	92.3	2.5	3.0	18
- 6		8828	27.99	15.77	156	0.0	0.0	92.5	2.0	2.0	26
- 7		9371	27.51	17.01	139	0.0	0.0	93.9	2.5	3.0	16
- 8		11567	37.71	15.28	149	0.0	0.0	95.5	2.0	2.0	20

TEST B900. FULL-SIB AND S_1 PROGENY PERFORMANCE UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1999-2000

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Bolters %	Root Rot %	Clean Beets %	Appearance Score 5/17	Appearance Score 6/06	NO3-N Mean
FS's from Y75											
Y975 - 1	RZM Y875PX	6127	20.81	13.99	151	0.0	20.0	93.0	4.0	3.0	20
- 2		4939	15.32	15.46	144	0.0	7.1	93.5	4.5	4.5	13
- 3		11118	38.25	14.48	149	0.0	3.7	95.4	3.0	2.5	24
- 4		5799	19.27	15.27	158	0.0	0.0	93.4	3.5	3.5	87
- 5		8818	28.73	15.17	162	4.8	0.0	93.8	2.5	3.0	34
- 6		5386	17.44	15.41	139	0.0	7.4	94.8	3.0	3.5	20
- 7		7878	25.70	15.10	158	0.0	10.7	92.4	3.0	3.5	42
- 8		6703	22.47	14.94	146	3.8	5.4	95.0	3.0	3.0	24
- 9		10231	32.75	15.60	136	0.0	2.2	96.5	2.5	3.0	52
-10		9718	32.74	14.86	161	0.0	0.0	95.2	3.0	3.0	22
-11		9688	31.27	15.45	158	0.0	0.0	94.9	2.0	2.0	29
-12		8048	23.54	16.56	142	2.1	3.7	93.1	3.0	3.0	25
-13		13025	40.30	16.18	151	0.0	0.0	92.3	1.0	1.0	29
-14		5873	18.71	15.59	144	0.0	2.0	93.7	4.0	4.5	31
-15		11318	36.26	15.57	142	0.0	0.0	94.6	2.0	1.5	19
-16		4316	14.02	15.27	156	0.0	5.4	90.1	4.0	4.0	19
-17		11086	36.20	15.24	168	0.0	0.0	93.1	2.0	2.0	32
-18		9326	29.08	16.23	147	0.0	3.6	94.2	3.0	3.0	23
-19		8429	26.14	16.41	152	0.0	1.7	93.9	3.0	2.5	17
-20		9244	31.27	14.81	150	0.0	0.0	94.4	2.5	2.5	79
S_1's from popn-926											
9926 - 1	RZM 8926(Iso)⊗	4813	14.89	16.17	140	0.0	4.3	92.4	4.5	4.0	15
- 2		6933	24.40	14.36	156	0.0	7.0	90.1	4.0	4.0	17
- 3		6572	20.68	15.91	167	0.0	3.7	92.6	3.0	3.0	24
- 4		3325	10.48	15.87	150	0.0	1.7	92.1	4.0	4.5	18
- 5		4249	13.66	15.30	161	0.0	10.3	92.3	3.5	4.5	20
- 6		4316	15.69	13.41	137	0.0	23.9	93.5	4.5	5.0	25
- 7		9102	29.37	15.49	144	0.0	2.1	95.0	3.5	4.0	24
- 8		4344	14.98	14.41	150	0.0	7.1	91.0	3.5	4.0	20

TEST B900. FULL-SIB AND S_1 PROGENY PERFORMANCE UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1999-2000

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolters	Root Rot	Clean Beets	Appearance Score		NO3-N
		Lbs	Tons	%	No.	%	%	%	5/17	6/06	Mean
S_1's from popn-926 (cont.)											
9926 - 9	RZM 8926(Iso)⊗	1535	5.49	14.28	153	0.0	3.6	90.7	4.5	5.0	29
-10		5119	17.17	14.33	136	0.0	11.5	94.0	3.5	4.0	15
-11		5939	18.60	15.81	161	0.0	3.4	90.9	3.0	2.5	18
-12		2211	7.45	14.28	158	0.0	6.9	90.6	4.0	3.5	20
-13		8633	27.43	15.79	135	0.0	0.0	93.8	3.0	3.0	17
-14		1497	4.62	15.61	147	0.0	3.8	86.4	4.5	4.5	21
-15		7285	23.20	15.77	136	0.0	0.0	93.2	3.0	4.0	13
-16		2148	6.65	16.15	154	0.0	1.8	91.5	4.0	4.5	29
S_1's from popn-934 (RZM 6913-70aa x R636)											
9934 - 1	RZM 7934⊗	6208	21.95	14.23	158	3.4	1.7	89.8	2.0	2.0	58
- 2		7489	22.84	16.33	146	0.0	0.0	93.1	3.0	3.0	14
- 3		9679	31.84	15.21	139	0.0	0.0	91.4	2.0	2.5	44
- 4		2239	7.42	15.17	125	38.2	16.0	90.5	4.5	5.0	14
- 5		5478	18.06	15.15	163	12.6	0.0	90.4	1.5	2.0	35
- 6		8547	28.84	14.79	144	0.0	0.0	95.0	3.0	4.0	44
- 7		4527	14.88	14.86	151	0.0	1.9	88.7	3.5	3.5	23
- 8		6155	21.58	14.22	150	0.0	0.0	93.8	2.0	3.0	43
- 9		5105	16.80	15.25	146	19.3	0.0	90.2	2.0	3.0	24
-10		7722	26.69	14.40	145	0.0	1.9	93.7	2.0	2.5	46
-11		2625	8.78	14.83	147	0.0	5.5	88.5	4.0	4.5	32
-12		7265	24.79	14.82	153	11.6	0.0	91.8	2.5	3.0	24
-13		4309	14.92	14.35	156	0.0	11.1	91.2	3.5	4.5	15
-14		5619	22.01	13.05	153	1.7	3.8	92.4	3.0	2.5	15
Mean		7260.1	23.67	15.27	148.0	1.6	3.0	92.9	2.9	3.1	29.2
LSD (.05)		4664.9	15.39	1.89	23.9	8.9	14.3	3.8	1.8	1.5	58.6
C.V. (%)		32.2	32.60	6.20	8.1	285.5	238.1	2.1	32.2	24.3	100.8
F value		2.6**	2.39**	1.46NS	1.2NS	3.0**	0.9NS	2.3**	2.0**	3.5**	0.9NS

TEST B900. FULL-SIB AND S_1 PROGENY PERFORMANCE UNDER RHIZOMANIA, IMPERIAL VALLEY, CA., 1999-2000 (cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Bolters	Root Rot	Clean Beets	Appearance Score		NO3-N
		Lbs	Tons	%	No.	%	%	%	5/17	6/06	Mean

NOTES: Trial was grown in a field plot area on the north side of Field K set up for evaluating performance under rhizomania. Except for checks, entries in test B900 were full-sib and S_1 progeny families being evaluated for reaction to rhizomania under high temperature conditions. All of these progeny had a germplasm component descended from C51 (C50,R22). C51 has been repeatedly shown under high temperature stress, rhizomania conditions to segregate for factor(s) that give higher resistance than *Rz* alone. This has been thought to be an additional factor for resistance to Rhizomania (BNYVV), but it may not be. This obvious resistance to some soilborne condition could be due to a different virus, to sugarbeet cyst nematode, or some other unknown factor. To develop field plot areas for high incidence of rhizomania, after soil inoculation for BNYVV, multiple beet crops have been grown with short rotations. These conditions designed to increase the intensity of BNYVV could also increase other soilborne pathogens and nematodes. Test B900 was designed to screen progeny lines for resistance to these soilborne problems. These same progeny families are being evaluated at Salinas for bolting, reaction to diseases, and performance.

Y967-#s = full-sib families from breeding line Y867. An earlier version of Y867 was released as C67. C67 has about 10% germplasm from *Beta vulgaris* ssp. *maritima* through C51(R22).

Y972-#s = full-sib families from breeding line Y872. An earlier version of Y872 was released as C72. C72 has about 5% germplasm from *B.vulgaris* ssp. *maritima* through C51(R22).

Y975-#s = full-sib families from breeding line Y875. Y875 represents additional backcrosses of lines such as C67 and C72 into sugarbeet.

9926-#s = S_1 lines from population-926. Popn-926 is a popn-931 type with a small germplasm component from C51.

9934=# = S_1 lines from population-934. Popn-934 was developed from lines C913-70 x C79-8. C79-8 ≈ C37 with resistance from C51.

% bolting = bolted biennial and annual plants from C51.

Root Rot = frequency of dead plants at harvest due to all causes including desication from rhizomania, other soilborne problems, rhizopus, etc.

Appearance Score = relative visual appearance (beauty scores) of plots on May 17 and June 6 before harvest. Scored from 1 to 5 where 1 = good, 3 = intermediate, 5 = poor. All factors taken into consideration including color, vigor, survival, etc.

TEST B1100. EVALUATION OF EXPERIMENTAL HYBRIDS FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, CA., 1999-2000

48 entries x 4 reps, sequential
1-row plots, 11+2½ ft. long

Planted: September 17, 1999
Not harvested for yield

Variety	Description	Stand Count Mean	Appearance Score 5/18	6/07	7/06	% Living Count	Segregation Pattern range
Checks							
B4776R	4776.9002, 9-8-99	20.3	3.3	3.3	3.8	35.4	3 - 5
Beta 4430R	4430.9041, 9-8-99	15.0	3.0	3.0	3.5	59.9	3
7CG7322	Betaseed, 9-13-99	17.0	3.3	4.3	4.0	17.0	3 - 4
Alpine	X612401, 9-10-99	16.5	2.8	3.3	3.5	32.9	3
US H11	susc. check, 9-14-99	18.8	4.5	4.5	5.0	4.5	4 - 5
R522(Sp)	RZM-%S R322R4,…(C51)	18.5	1.5	1.8	2.3	52.4	1 - 2
R522H50	C790-15CMS x RZM R522(C)	15.0	1.8	2.0	2.8	42.6	1 - 3
Phoenix	1392401, 9-10-99	18.5	4.0	4.5	4.8	11.4	4 - 5
Pollinators							
Y969 (Iso)	RZM-ER-% Y769, C69	16.5	3.5	3.8	3.3	39.7	3 - 5
Y975	RZM Y875 (C51 resistance)	19.0	2.5	2.5	3.3	32.6	1 - 5
9931	RZM 8931aa x A	20.5	4.0	4.5	4.8	10.3	4 - 5
9926	RZM 8926aa x A (C51 resist)	18.8	2.5	3.3	4.0	18.0	1 - 5
Hybrids to C69							
Y969H50(Iso)	C790-15CMS x RZM-ER-% Y769	19.3	3.3	4.0	4.0	21.6	3 - 5
Y969H5	C833-5aa x Y769	17.0	3.5	3.8	3.8	35.6	3 - 5
Y969H35	8835aa x Y869	20.0	3.3	3.3	4.0	21.6	3 - 5
Y969H10	8810aa x Y869	19.0	2.8	3.0	3.3	30.3	1 - 5
Y969H48	8848aa x Y869	21.5	2.8	3.3	4.0	20.4	2 - 5
Y969H17	7817HO x Y869	20.3	4.3	4.8	5.0	11.6	3 - 5
Y969H18	7818HO x Y869	19.5	3.8	3.8	4.5	14.6	1 - 5
Y969H18-1B	8818-1BHO x Y869	17.3	3.0	3.5	4.5	9.3	2 - 4
Y969H18-2B	8818-2BHO x Y869	19.3	2.8	3.3	3.5	21.9	2 - 5
Hybrids to Y75							
Y975H50	C790-15CMS x RZM Y875	20.5	2.3	2.8	3.0	40.9	1 - 4
Y975H6	C833-5H50 x RZM Y875	19.8	2.8	3.0	3.3	29.3	2 - 5
Y975H5	C833-5aa x RZM Y875	19.8	2.8	2.5	3.0	36.5	1 - 4
Y975H35	8835aa x RZM Y875	18.0	3.0	3.3	3.5	30.6	2 - 4
Y975H10	8810aa x RZM Y875	18.5	2.8	3.0	4.0	25.3	2 - 4
Checks							
US H11	susc. check, 9-14-99	19.8	4.0	4.8	5.0	7.6	4 - 5
R522(Sp)	RZM-%S R322R4,…(C51)	19.5	1.3	1.8	1.5	57.7	1 - 2

TEST B1100. EVALUATION OF EXPERIMENTAL HYBRIDS FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, CA., 1999-2000

(cont.)

Variety	Description	Stand Count Mean	Appearance Score 5/18	Appearance Score 6/07	Appearance Score 7/06	% Living Count	Segregation Pattern range
Hybrids to popn-931							
9931H50	C790-15CMS x RZM 8931	18.8	4.0	4.3	4.5	26.0	4 - 5
9931H35	8835aa x RZM 8931	21.0	4.3	3.8	4.3	18.0	4 - 5
Hybrids to popn-926							
9926H50	C790-15CMS x 8926	20.5	3.0	3.3	4.0	24.1	1 - 5
9926H6	C833-5H50 x 8926	20.0	3.3	3.0	3.3	44.6	1 - 5
9926H35	8835aa x 8926	19.0	3.0	3.3	3.8	30.2	2 - 4
9926H48	8848aa x 8926	20.3	3.0	2.8	3.5	33.3	1 - 4
Hybrids to other pollinators							
Y967H50	C790-15CMS x RZM-ER-% Y767(C67)	20.0	3.3	3.5	3.8	26.2	1 - 5
Y971H50	C790-15CMS x RZM-ER-% Y771	19.8	2.8	3.0	3.8	25.0	1 - 5
R940H50	C790-15CMS x RZM-ER-% R740(C79)	21.5	2.3	2.8	3.5	31.3	1 - 4
R943H50	C790-15CMS x RZM-ER-% R643	14.8	2.5	2.5	3.3	37.2	1 - 5
9934H50	C790-15CMS x RZM 8934(C)	15.8	2.8	2.8	3.5	37.6	2 - 5
R936H50	C790-15CMS x RZM-ER-% R736(C79-8)	19.8	2.5	2.5	3.0	36.6	2 - 4
R954H50	C790-15CMS x RZM-ER-% R754,R746	18.0	2.3	2.5	3.3	36.7	1 - 5
P909H50	C790-15CMS x RZM-PMR P809,10	19.8	3.3	4.0	4.0	15.1	2 - 5
P912H50	C790-15CMS x PM-RZM P812	21.0	2.8	3.0	3.5	24.8	2 - 4
P911H50	C790-15CMS x RZM-PMR P811	19.3	3.3	3.3	3.5	23.5	1 - 5
9927-4H50	C790-15CMS x 7927-4VY	18.8	1.0	1.8	1.5	74.7	1 - 4
9927-17H50	C790-15CMS x 7927-17VY	19.8	3.5	4.0	3.8	27.7	3 - 4
9928-34H50	C790-15CMS x 7928-34	19.8	3.3	3.8	4.0	27.9	2 - 5
9928-107H50	C790-15CMS x 7928-107	19.5	3.8	4.0	4.0	16.4	3 - 5
Mean		19.0	3.0	3.3	3.7	28.9	
LSD (.05)		4.2	0.9	0.8	1.1	20.5	
C.V. (%)		15.7	21.8	16.9	20.4	50.8	
F value		1.2NS	5.2**	7.6**	4.0**	3.7**	

NOTES: See notes for Tests B900, B1200 & B1300.

Hybrids 9927-4H50, etc. correspond to pollinators 9927-4, etc. in Test B1200. S_1 line 9927-4 has a C51 component. Both as the line 9927-4 (Test B1200) and as hybrid shown here, it gave a very strong resistance reaction to the conditions present in these tests (also see Tests B300 & B600).

TEST B1200. EVALUATION OF MULTIGERM LINES FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, CA., 1999-2000

64 entries x 4 reps, sequential
1-row plots, 11+2½ ft. long

Planted: September 17, 1999
Not harvested for yield

Variety	Description	Stand Count Mean	Appearance Score 5/18	Appearance Score 6/07	Appearance Score 7/06	% Living Count	Segregation Pattern range
Checks							
Rizor	HH108, 9-3-97	22.5	3.0	3.3	3.5	41.1	3 - 4
Rifle	L1162401, 9-98	19.8	3.0	3.5	3.3	40.1	4
Alpine	X612401, 9-10-99	19.8	3.0	3.5	3.5	35.5	4
Phoenix	1392401, 9-10-99	21.5	4.0	4.5	4.5	27.1	4 - 5
US H11	susc. check	20.8	4.0	4.0	4.3	18.2	3 - 5
R522(Sp)	RZM-%S R322R4,…(C51)	18.8	1.5	2.0	1.8	68.1	1 - 2
B4776R	4776.9002, 9-8-99	20.0	3.5	3.3	3.5	45.1	3 - 5
7CG7322	Betaseed, 9-13-99	18.3	4.0	4.0	4.3	36.6	4 - 5
B4430R	4430.9041, 9-8-99	22.3	3.0	3.5	2.5	73.7	3 - 4
Multigerm, S^sS^s lines							
99-C46/2	Inc. U86-46/2	21.3	4.0	4.3	4.5	16.3	4
R978	RZM-ER-% R778,%,(C78)	22.8	3.5	3.8	4.0	23.4	4
R980	RZM-ER-% R780/2,-45,(C80)	22.0	3.3	3.3	3.0	42.5	3 - 5
R970	RZM-ER-% R770	20.0	4.0	4.3	4.5	11.6	4 - 5
Y967	RZM-ER-% Y767,(C67)	19.3	2.5	2.5	3.3	41.9	1 - 5
Y875(Iso)	RZM Y775	20.0	2.8	2.5	3.5	25.7	1 - 5
Y975	RZM Y875	20.5	2.5	3.0	3.0	32.8	1 - 5
Y873	RZM-ER-% Y673	23.0	2.8	2.5	2.8	45.2	1 - 4
R940	RZM-ER-% R740,(C79)	21.0	2.3	2.3	2.3	55.2	2 - 5
R928	RZM R728,(C79-4)	22.3	4.5	4.8	4.5	12.0	3 - 5
R879	RZM R779, C79-1*Rz*	19.8	5.0	4.8	4.5	16.7	4 - 5
99-C37	Inc. U86-37	21.8	4.8	5.0	5.0	7.9	5
R936	RZM-ER-% R736,(C79-8)	21.0	3.3	3.3	3.5	43.7	2 - 3
R954	RZM-ER-% R754,R746	20.5	3.0	3.8	4.0	29.1	3 - 4
Y971	RZM-ER-% Y771	20.5	2.8	3.0	3.5	32.9	2 - 3
Y872	RZM-% Y672,(C72)	20.8	1.8	2.3	2.3	64.9	1 - 2
99-C31/6	Inc. F86-C31/6	21.8	4.8	4.5	4.5	18.8	5
R943	RZM-ER-% R643	21.8	3.0	3.3	3.5	31.2	2 - 4
Y969(Iso)	RZM-ER-% Y769,C69	23.0	4.3	3.8	3.8	23.0	3 - 4
R976-89	R876-89-5rr x R576-89-18	20.3	4.5	4.8	5.0	3.6	4 - 5
R976-89-18	Inc. R576-89-18,NB	20.0	4.5	4.8	5.0	3.7	4 - 5
R926	RZM R826 (C26)	20.0	3.0	3.5	3.5	47.5	2 - 5
R927	RZM R827 (C27)	19.8	3.3	4.0	4.0	25.1	3 - 5

TEST B1200. EVALUATION OF MULTIGERM LINES FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, CA., 1999-2000

(cont.)

Variety	Description	Stand Count Mean	Appearance Score 5/18	Appearance Score 6/07	Appearance Score 7/06	% Living Count	Segregation Pattern range
Multigerm, S^sS^s lines (cont.)							
N972	RZM N872,N771(C) (SBCNR)	20.3	2.5	2.5	3.0	38.1	1 - 5
99-WB242	Inc. WB 242 (PMR,SBCNR)	21.8	2.3	2.8	2.8	35.7	1 - 5
P907	RZM-PMR P807,8(C)	21.3	2.8	2.8	2.8	41.3	1 - 5
P909	RZM-PMR P809,10(C)	21.8	3.3	3.3	3.5	31.1	3 - 5
P911	RZM-PMR P811	18.5	3.8	3.5	4.0	17.9	1 - 5
P912	PM-RZM P812	20.0	2.3	2.3	2.8	41.4	1 - 5
99-C37	Inc. U86-37	18.3	5.0	4.8	4.8	11.0	4 - 5
P915	RZM-PMR P815,16(C)	20.0	4.3	4.3	4.3	17.8	3 - 5
P913	PMR P813,CP01,WB97	21.5	4.0	3.8	3.8	36.7	2 - 5
P914	PMR P814,CP02,WB242	19.0	4.8	4.8	4.5	19.5	3 - 5
US H11	susc. check, 9-14-99	22.8	4.5	4.0	4.3	22.0	4 - 5
R522(Sp)	RZM-%S R322R4,...(C51)	19.5	1.5	2.3	1.5	64.6	1 - 3
Multigerm, S^f,Aa populations							
7747	Inc. 5747(A,aa)	19.8	4.5	4.5	5.0	13.7	4 - 5
9926	RZM 8926(C)aa x A	21.8	2.8	2.8	3.0	38.6	1 - 5
9934	RZM 8934(C)	19.8	2.8	3.3	3.5	36.1	1 - 5
9931	RZM 8931(C)aa x A	20.8	4.0	4.5	4.0	22.2	3 - 5
9932	RZM 8932aa x A	21.5	3.8	4.3	4.3	18.4	3 - 5
9933	RZM 8933(C)aa x A	19.5	3.8	4.0	3.8	28.0	2 - 5
9941	941(C)aa x A	21.3	4.8	4.3	4.5	15.8	4 - 5
9924	RZM 8924(C)aa x A	21.5	4.3	4.5	4.8	9.4	3 - 5
Z925	RZM-ER-% Z725(C)	20.3	3.8	4.0	4.3	22.1	3 - 5
CR910	RZM R710;R709-9;R710-10,-14	21.3	4.0	4.3	4.3	26.3	2 - 5
CR909-1	RZM R709-1	18.0	5.0	4.5	4.5	10.5	5
CR911	RZM CR811(C)aa x A	18.3	3.3	3.8	3.5	46.4	3 - 5
CR912	RZM-ER-% CR711,712	19.5	4.0	4.0	4.0	25.3	3 - 5
9719Bm	Inc. 6719 (C719Bm)	19.3	5.0	5.0	5.0	9.3	5
99-FC-1,2,3M	RZM-ER-% FC-1,2,3M	20.8	4.8	5.0	4.8	7.5	4 - 5
99-EL-02,04	RZM 98-EL-02,04	20.3	3.5	3.5	3.0	50.5	3 - 5
9927-4	Inc. 7927-4VY	21.0	1.8	2.5	3.0	45.5	1 - 5
9927-17	Inc. 7927-17VY	19.3	4.3	4.3	4.0	36.5	4 - 5
9928-34	Inc. 7928-34	19.8	2.3	3.3	3.5	37.4	2 - 5
9928-107	Inc. 7928-107	19.0	2.8	3.0	3.3	44.9	2 - 5
Mean		20.5	3.5	3.7	3.7	30.7	
LSD (.05)		3.8	0.8	0.8	0.9	18.0	
C.V. (%)		13.4	17.1	14.7	16.3	42.1	
F value		0.8NS	9.9**	9.4**	7.2**	6.3**	

TEST B1200. EVALUATION OF MULTIGERM LINES FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, CA., 1999-2000

(cont.)

Variety	Description	Stand Count	Appearance Score			% Living	Segregation Pattern
		Mean	5/18	6/07	7/06	Count	range

NOTES: An area in Field K has been developed to have severe rhizomania. Since rhizomania was identified in this localized area in about 1989, a beet crop has been grown every other year. This 2 acre area (1 acre used/year) has been used for observation trials to evaluate the apparent resistance to rhizomania under the combined effects of rhizomania and high temperature stress. Of course such a close rotation to promote the development of high BNYVV inoculum would also promote the development of other soilborne pathogens of sugarbeet, such as sugarbeet cyst nematode (SBCN). Early in the use of this area, it was observed that certain germplasm with a *Beta vulgaris* ssp. *maritima* (*Bvm*) component performed much better than any other breeding material. This area has been used to evaluate this *Bvm* breeding material and to screen breeding lines and progeny families in the transfer of this desirable resistance trait into sugarbeet. This C51 (C50,R22,C67,C72) germplasm was thought to segregate for an additional factor or allele for resistance to rhizomania. However, it is actually not known for what soilborne pathogen this factor is conditioning high resistance. It is conceivable that this may actually be resistance to SBCN. In addition to this resistance being found in C50,C51,R22, etc., germplasm, it also has been found to occur in WB242. WB242 (*Bvm*) has been used as a source of near-immunity to powdery mildew. Within WB242 (see above) and some of the PMR backcross families, a very high level of resistance is found to the conditions of this test (see P907,P911,P912 above). This year, similarly high resistance was found in line N972 (see above). N972 is BC_1 line (25% *Bvm*) that used a SBCN resistant *Bvm* line obtained from KWS. The only thing that seems to be understood at this point is that within a certain set of *Bvm* germplasm, there is high resistance against some soilborne pathogen. This resistance appears to be highly heritable, simply inherited, and dominant.

Appearance score = relative visual appearance (beauty scores) of plots on May 18 and June 7 where 1 = good, 3 = intermediate, 5 = poor. All factors taken into consideration including vigor, color, survival, etc.

Segregation pattern = range of individual plants within a plot for appearance. For example, 1 -5 means that within a plot, plants ranged from appearance score 1 to score 5.

TEST B1300. EVALUATION OF PROGENY LINES (FS & S_1) FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1999-2000

256 entries x 1 or 2 reps, sequential
1-row plots, 11+2½ ft. long

Planted: September 17, 1999
Not harvested for yield

Variety	Description	Stand Count Mean	Appearance Score 5/18	Appearance Score 6/07	Appearance Score 7/06	% Living count	Bolting %	Seg Pattern range
Checks								
US H11	susc. check, 9-14-99	22.0	4.0	4.0	5.0	13.6	0.0	3 - 4
US H11		22.0	4.0	4.0	3.0	31.8	0.0	3 - 4
R522(Sp)	RZM-%S R322R4,...(C51)	19.0	2.0	2.0	2.0	57.9	10.5	1 - 3
R522(Sp)		21.0	2.0	1.0	1.0	47.6	9.5	1 - 3
Y967	RZM-ER-% Y767, (C67)	26.0	2.0	3.0	3.0	42.3	0.0	1 - 4
Y967		19.0	2.0	2.0	3.0	63.2	0.0	1 - 4
Y975	RZM Y875	24.0	3.0	3.0	4.0	8.3	0.0	1 - 4
Y975		15.0	2.0	2.0	3.0	40.0	0.0	1 - 4
99-C37	Inc. U86-37	14.0	5.0	4.0	5.0	0.0	0.0	4 - 5
99-C37		21.0	5.0	5.0	5.0	4.8	0.0	4 - 5
R936	RZM-ER-% R736, (C79-8)	13.0	3.0	4.0	4.0	30.8	0.0	2 - 4
R936		18.0	3.0	2.0	3.0	44.4	0.0	2 - 4
Y971	RZM-ER-% Y771	20.0	3.0	4.0	5.0	10.0	0.0	2 - 5
Y971		19.0	3.0	3.0	4.0	26.3	0.0	2 - 5
R943	RZM-ER-% R643	19.0	2.0	2.0	4.0	21.1	0.0	2 - 3
R943		18.0	2.0	3.0	3.0	27.8	11.1	2 - 3
P907	RZM-PMR P807,8(C)	20.0	2.0	2.0	2.0	65.0	0.0	1 - 3
P907		22.0	2.0	3.0	3.0	22.7	0.0	1 - 3
P911	RZM-PMR P811	21.0	5.0	4.0	4.0	14.3	0.0	2 - 5
P911		19.0	4.0	4.0	3.0	63.2	0.0	2 - 5
P909	RZM-PMR P909,10(C)	22.0	3.0	3.0	3.0	50.0	4.5	1 - 4
P909		24.0	3.0	3.0	3.0	16.7	0.0	1 - 4
P912	PM-RZM P812	20.0	1.0	1.0	3.0	55.0	0.0	1 - 5
P912		21.0	3.0	3.0	5.0	4.8	0.0	1 - 5
P915	RZM-PMR P815,16(C)	20.0	3.0	2.0	3.0	40.0	0.0	1 - 4
P915		21.0	3.0	3.0	5.0	14.3	0.0	1 - 4
P913	PMR P813,CP01,WB97	19.0	4.0	4.0	3.0	42.1	0.0	3 - 4
P913		22.0	4.0	4.0	4.0	22.7	0.0	3 - 4
P914	PMR P814,CP01,WB242	19.0	4.0	4.0	5.0	10.5	0.0	3 - 4
P914		21.0	4.0	4.0	4.0	23.8	0.0	3 - 4
R978	RZM-ER-% R778,%, (C78)	20.0	4.0	3.0	3.0	30.0	0.0	2 - 4
R978		22.0	2.0	3.0	3.0	40.9	0.0	2 - 4
Segregate for resistance to *Rz* & *Pm*								
P917 - 1B	P815 x C37	20.0	3.0	4.0	4.0	15.0	0.0	3 - 5
P917 - 2	C37 x P815	9.0	4.0	4.0	4.0	44.4	0.0	4
- 3B		19.0	3.0	4.0	4.0	21.1	0.0	3 - 4
- 4B		18.0	3.0	3.0	2.0	66.7	0.0	3 - 4

TEST B1300. EVALUATION OF PROGENY LINES (FS & S_1) FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1999-2000

(cont.)

Variety	Description	Stand Count Mean	Appearance 5/18	Appearance 6/07	Score 7/06	% Living count	Bolting %	Seg Pattern range
Segregate for resistance to *Rz* & *Pm* (cont.)								
P917 - 5B	P815 x C37	14.0	4.0	4.0	3.0	21.4	0.0	3 - 4
- 6B		13.0	3.0	3.0	3.0	46.2	0.0	2 - 4
- 7B		19.0	3.0	4.0	5.0	10.5	0.0	3 - 4
- 8B		18.0	4.0	3.0	3.0	38.9	0.0	3 - 4
- 9B		21.0	3.0	3.0	3.0	71.4	0.0	2 - 3
-10B		18.0	4.0	5.0	3.0	50.0	0.0	4
-11B		22.0	4.0	4.0	4.0	27.3	0.0	3 - 4
-12	C37 x P815	14.0	5.0	4.0	3.0	78.6	0.0	4
-13B		19.0	3.0	3.0	3.0	57.9	0.0	4
-14B		20.0	4.0	4.0	3.0	40.0	0.0	4
P918 - 1B	P816 x C37	18.0	3.0	3.0	3.0	55.6	0.0	3 - 4
- 2B		18.0	5.0	5.0	3.0	27.8	0.0	5
P918 - 3	C37 x P816	23.0	2.0	3.0	3.0	52.2	0.0	3
- 4		16.0	3.0	3.0	4.0	56.3	6.3	4
- 5		15.0	3.0	4.0	4.0	46.7	0.0	4
- 6B	P816 x C37	16.0	3.0	3.0	3.0	62.5	0.0	1 - 5
- 7B		17.0	4.0	4.0	3.0	47.1	0.0	5
- 8B		19.0	3.0	2.0	2.0	42.1	0.0	1 - 5
- 9B		17.0	2.0	2.0	2.0	41.2	0.0	1 - 5
-10B		22.0	5.0	5.0	5.0	4.5	0.0	5
-11B		3.0	3.0	3.0	3.0	66.7	66.7	2 - 3
-12B		18.0	4.0	4.0	4.0	38.9	0.0	4
P922 - 1B	RZM-PMR P811 x C37	17.0	3.0	3.0	4.0	47.1	0.0	2 - 4
P919 - 1B	RZM-PMR P809 x RZM R878%	16.0	2.0	3.0	3.0	81.3	18.8	1 - 4
- 2B		17.0	2.0	3.0	3.0	64.7	0.0	2 - 3
- 3B		18.0	4.0	4.0	3.0	66.7	5.6	3 - 5
- 5B		20.0	4.0	5.0	3.0	60.0	0.0	2 - 5
- 6B		18.0	5.0	5.0	4.0	33.3	0.0	5
- 7B		22.0	2.0	3.0	3.0	54.5	0.0	2 - 4
- 8B		17.0	5.0	5.0	5.0	23.5	0.0	5
- 9B		20.0	3.0	4.0	4.0	20.0	0.0	3 - 4
-11	RZM R878% x RZM-PMR P809B	18.0	3.0	3.0	3.0	55.6	0.0	4
-12B		16.0	3.0	4.0	4.0	18.8	0.0	2 - 5
-13B		18.0	3.0	3.0	3.0	33.3	0.0	2 - 4
-14B		23.0	3.0	3.0	2.0	39.1	0.0	2 - 4
-15B		20.0	4.0	4.0	4.0	15.0	0.0	4

TEST B1300. EVALUATION OF PROGENY LINES (FS & S_1) FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1999-2000

(cont.)

Variety	Description	Stand Count Mean	Appearance Score 5/18	6/07	7/06	% Living count	Bolting %	Seg Pattern range
Segregate for resistance to *Rz* & *Pm* (cont.)								
P920 - 1B	RZM-PMR P810 x RZM R878%	18.0	2.0	2.0	2.0	66.7	0.0	2
- 2B		18.0	4.0	4.0	4.0	27.8	0.0	4
- 4B		16.0	3.0	3.0	3.0	56.3	0.0	2 - 4
- 5B		18.0	4.0	4.0	3.0	55.6	0.0	4
- 6B		15.0	4.0	4.0	3.0	40.0	0.0	4
- 7B		24.0	4.0	4.0	4.0	25.0	0.0	3 - 4
- 8	RZM R878% x RZM-PMR P810	20.0	4.0	3.0	3.0	65.0	0.0	2 - 4
- 9B		22.0	4.0	4.0	3.0	31.8	0.0	4
P920 -11B	RZM-PMR P810B x RZM R878%	21.0	3.0	3.0	3.0	38.1	0.0	3 - 4
-12B		16.0	4.0	5.0	4.0	6.3	0.0	4
-13B		18.0	5.0	5.0	4.0	5.6	0.0	5
-14	RZM R878% x RZM-PMR P810B	20.0	3.0	3.0	2.0	75.0	0.0	3
P920 -15B	RZM-PMR P810B x RZM R878%	20.0	4.0	4.0	2.0	65.0	0.0	4
-16B		21.0	4.0	3.0	3.0	42.9	0.0	4
-17B		23.0	5.0	4.0	2.0	52.2	0.0	5
-18B		18.0	5.0	5.0	5.0	0.0	0.0	5
P921 - 1B	RZM-PMR P811 x RZM R878%	19.0	3.0	3.0	4.0	47.4	0.0	3 - 5
- 2B		19.0	2.0	2.0	1.0	63.2	10.5	1 - 3
- 3B		19.0	4.0	4.0	3.0	42.1	0.0	4
- 4B		22.0	4.0	4.0	3.0	54.5	0.0	5
P921 - 5	R878% x RZM-PMR P811	16.0	5.0	4.0	3.0	37.5	0.0	5
- 6B		18.0	3.0	2.0	2.0	61.1	5.6	1 - 5
- 7B		20.0	5.0	5.0	5.0	10.0	0.0	5
- 8B		19.0	5.0	4.0	3.0	47.4	0.0	5
- 9B		23.0	2.0	3.0	2.0	43.5	0.0	2
-10B		15.0	4.0	4.0	3.0	40.0	0.0	4
P925 - 1B	RZM R878% x P815	21.0	4.0	5.0	4.0	42.9	0.0	4
- 2B		20.0	4.0	5.0	5.0	15.0	0.0	4
- 3B		16.0	4.0	4.0	3.0	37.5	25.0	4
- 4B		20.0	4.0	4.0	3.0	55.0	0.0	4
- 5B		23.0	5.0	4.0	3.0	34.8	0.0	5
- 6B		16.0	5.0	5.0	4.0	37.5	0.0	5
P925 - 7B	RZM R878% x P815	18.0	3.0	3.0	4.0	27.8	0.0	3
- 8B		19.0	3.0	3.0	3.0	73.7	0.0	3
- 9B		9.0	3.0	3.0	3.0	88.9	0.0	3 - 4
-10B		17.0	4.0	5.0	4.0	11.8	0.0	4

TEST B1300. EVALUATION OF PROGENY LINES (FS & S_1) FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1999-2000

(cont.)

Variety	Description	Stand Count Mean	Appearance 5/18	Appearance 6/07	Score 7/06	% Living count	Bolting %	Seg Pattern range
Segregate for resistance to *Rz* & *Pm* (cont.)								
P925 -11B	RZM R878% x P815	12.0	3.0	4.0	3.0	58.3	0.0	3 - 4
-12B		6.0	3.0	3.0	3.0	83.3	0.0	2 - 4
P926 - 1B	RZM R878% x P816	13.0	4.0	4.0	4.0	15.4	0.0	2 - 4
- 2B		19.0	4.0	4.0	4.0	26.3	0.0	3 - 4
- 3B		19.0	2.0	3.0	3.0	68.4	0.0	2 - 4
- 4B		22.0	3.0	3.0	3.0	63.6	0.0	3
- 5B		16.0	4.0	4.0	4.0	31.3	0.0	4
- 6B		9.0	3.0	3.0	3.0	66.7	0.0	3 - 4
- 7B		18.0	4.0	4.0	3.0	55.6	0.0	4
- 8B		21.0	3.0	4.0	3.0	57.1	0.0	2 - 5
- 9B		18.0	5.0	5.0	3.0	27.8	0.0	5
-10B		19.0	5.0	4.0	3.0	42.1	0.0	5
-11B		18.0	2.0	3.0	2.0	66.7	0.0	2 - 4
-12B		17.0	2.0	3.0	2.0	70.6	5.9	2 - 4
-13B		14.0	3.0	3.0	4.0	35.7	0.0	3 - 4
P924 - 1B	RZM-PMR P810 x C37	18.0	4.0	4.0	5.0	16.7	0.0	3 - 4
- 2B		21.0	4.0	4.0	3.0	66.7	0.0	4
- 3B		19.0	5.0	4.0	3.0	57.9	0.0	5
- 4B		23.0	4.0	4.0	3.0	30.4	0.0	4 - 5
R978	RZM-ER-% R778,%, (C78)	22.0	4.0	4.0	5.0	9.1	0.0	3 - 5
US H11	susc. check, 9-14-99	25.0	3.0	3.0	3.0	36.0	0.0	2 - 4
US H11		24.0	5.0	5.0	5.0	8.3	0.0	2 - 4
R522(Sp)	RZM-%S R322R4,...(C51)	20.0	1.0	2.0	1.0	65.0	15.0	1 - 2
R522(Sp)		18.0	1.0	2.0	1.0	77.8	11.1	1 - 2
Y967	RZM-ER-% Y767, (C67)	21.0	3.0	2.0	2.0	71.4	0.0	1 - 4
Y967		21.0	2.0	3.0	2.0	66.7	0.0	1 - 4
Y975	RZM Y875	18.0	3.0	3.0	3.0	38.9	0.0	2 - 4
Y975		24.0	3.0	3.0	2.0	58.3	0.0	2 - 4
99-C37	Inc. U86-37	21.0	5.0	5.0	5.0	4.8	0.0	5
99-C37		21.0	5.0	5.0	5.0	19.0	0.0	5
R936	RZM-ER-% R736, (C79-8)	17.0	2.0	2.0	2.0	70.6	0.0	2 - 3
R936		22.0	1.0	2.0	2.0	63.6	0.0	2 - 3
P907	RZM-PMR P807,8(C)	20.0	3.0	3.0	3.0	35.0	0.0	1 - 5
P907		21.0	3.0	3.0	3.0	38.1	0.0	1 - 5
P911	RZM-PMR P811	22.0	3.0	2.0	2.0	36.4	0.0	1 - 5
P911		18.0	2.0	3.0	2.0	72.2	0.0	1 - 5

TEST B1300. EVALUATION OF PROGENY LINES (FS & S_1) FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1999-2000

(cont.)

Variety	Description	Stand Count Mean	Appearance Score 5/18	Appearance Score 6/07	Appearance Score 7/06	% Living count	Bolting %	Seg Pattern range
FS progeny families								
Y967 - 1	RZM Y867 PX	17.0	3.0	4.0	4.0	23.5	0.0	4
- 2		21.0	3.0	4.0	4.0	14.3	0.0	3 - 4
- 3		16.0	2.0	3.0	3.0	56.3	0.0	2 - 3
- 4		23.0	2.0	3.0	3.0	43.5	0.0	3
- 5		21.0	2.0	2.0	3.0	42.9	0.0	2 - 3
- 6		19.0	3.0	3.0	5.0	5.3	0.0	2 - 3
- 7		20.0	1.0	3.0	2.0	90.0	0.0	2 - 3
- 8		20.0	1.0	3.0	3.0	60.0	0.0	2
- 9		18.0	2.0	3.0	3.0	61.1	0.0	3
-10		18.0	2.0	3.0	3.0	66.7	0.0	3
-11		15.0	4.0	4.0	4.0	20.0	0.0	4
-12		23.0	2.0	3.0	2.0	47.8	0.0	2 - 3
-13		17.0	3.0	3.0	3.0	47.1	0.0	3
Y972 - 1	RZM Y872 PX	21.0	1.0	2.0	2.0	76.2	0.0	2
- 2		19.0	3.0	3.0	3.0	31.6	0.0	2 - 3
- 3		23.0	3.0	3.0	4.0	21.7	0.0	3
Y972 - 4	RZM Y872 PX	17.0	3.0	3.0	3.0	70.6	0.0	2 - 4
- 5		20.0	3.0	3.0	3.0	35.0	0.0	2 - 4
- 6		21.0	3.0	3.0	3.0	52.4	0.0	2 - 4
- 7		27.0	2.0	2.0	2.0	66.7	0.0	2 - 3
- 8		21.0	2.0	3.0	3.0	57.1	0.0	2 - 3
- 9		22.0	2.0	3.0	3.0	50.0	0.0	2
-10		14.0	2.0	2.0	3.0	42.9	0.0	2 - 4
Y975 - 1	RZM Y875 PX	23.0	2.0	4.0	5.0	8.7	0.0	3
- 2		21.0	5.0	5.0	5.0	4.8	0.0	5
- 3		20.0	3.0	3.0	4.0	30.0	0.0	2 - 4
- 4		21.0	3.0	3.0	3.0	52.4	0.0	3
- 5		27.0	3.0	3.0	4.0	18.5	0.0	3
- 6		21.0	2.0	3.0	3.0	38.1	0.0	3
- 7		20.0	2.0	3.0	3.0	60.0	0.0	3
- 8		21.0	1.0	2.0	3.0	38.1	9.5	1 - 4
- 9		22.0	2.0	3.0	3.0	22.7	0.0	3
-10		18.0	2.0	3.0	3.0	50.0	0.0	3
-11		23.0	1.0	1.0	2.0	69.6	0.0	1 - 2
-12		21.0	4.0	4.0	3.0	42.9	0.0	3
-13		25.0	1.0	1.0	1.0	64.0	0.0	1 - 2

TEST B1300. EVALUATION OF PROGENY LINES (FS & S_1) FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1999-2000

(cont.)

Variety	Description	Stand Count Mean	Appearance 5/18	Appearance 6/07	Score 7/06	% Living count	Bolting %	Seg Pattern range
S_1 progeny lines (cont.)								
9926 -15	RZM 8926(Iso)⊗	12.0	3.0	3.0	3.0	58.3	0.0	3
-16		17.0	4.0	4.0	4.0	35.3	0.0	4
-17		19.0	5.0	5.0	5.0	0.0	0.0	5
-18		19.0	4.0	4.0	4.0	26.3	0.0	4
-19		19.0	5.0	5.0	5.0	5.3	0.0	5
-20		17.0	5.0	5.0	5.0	0.0	0.0	5
-21		17.0	5.0	5.0	5.0	17.6	0.0	5
-22		20.0	4.0	5.0	5.0	15.0	0.0	4
-23		12.0	3.0	4.0	5.0	0.0	0.0	3
-24		18.0	3.0	4.0	4.0	33.3	5.6	3
-25		20.0	4.0	4.0	3.0	40.0	0.0	2 - 4
-26		17.0	5.0	4.0	4.0	23.5	0.0	4
-27		15.0	3.0	3.0	3.0	73.3	0.0	2 - 4
-28		3.0	4.0	4.0	5.0	0.0	0.0	4
-29		22.0	5.0	5.0	5.0	9.1	0.0	5
9934 - 1	RZM 7934⊗	23.0	2.0	3.0	3.0	34.8	0.0	2
- 2		19.0	3.0	3.0	3.0	78.9	0.0	3
- 3		20.0	1.0	2.0	3.0	55.0	0.0	1
9934 - 4	RZM 7934⊗	19.0	5.0	5.0	5.0	0.0	0.0	5
- 5		22.0	2.0	2.0	2.0	54.5	0.0	2
- 6		18.0	3.0	3.0	3.0	61.1	0.0	3 - 4
9934 -15	RZM 7934⊗	23.0	5.0	4.0	3.0	30.4	0.0	5
-16		20.0	4.0	4.0	4.0	25.0	0.0	4
-17		23.0	2.0	3.0	2.0	56.5	0.0	2
-18		22.0	5.0	5.0	5.0	0.0	0.0	5
-19		26.0	2.0	3.0	2.0	76.9	0.0	2
9934 - 7	RZM 7934⊗	20.0	5.0	5.0	4.0	15.0	0.0	5
- 8		21.0	2.0	2.0	2.0	57.1	0.0	2 - 4
- 9		23.0	2.0	3.0	3.0	56.5	0.0	2 - 4
-10		22.0	2.0	3.0	2.0	68.2	0.0	2 - 4
-11		19.0	5.0	5.0	5.0	21.1	0.0	5
-12		22.0	1.0	3.0	3.0	45.5	0.0	2
-13		19.0	5.0	5.0	4.0	26.3	0.0	4
-14		21.0	2.0	3.0	3.0	42.9	0.0	2 - 3

TEST B1300. EVALUATION OF PROGENY LINES (FS & S_1) FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1999-2000

(cont.)

Variety	Description	Stand Count Mean	Appearance Score 5/18	Appearance Score 6/07	Appearance Score 7/06	% Living count	Bolting %	Seg Pattern range
Rz/SBCN resistant backcrosses								
N925 - 1	RZM 7931aa x N724	20.0	3.0	3.0	4.0	20.0	0.0	2 - 4
- 4		16.0	3.0	3.0	3.0	81.3	0.0	3
- 5		20.0	2.0	2.0	3.0	60.0	0.0	3
- 7		20.0	4.0	4.0	3.0	45.0	0.0	4
N931 - 2	RZM 7931aa x N730	19.0	4.0	3.0	3.0	52.6	0.0	2 - 4
- 6		24.0	4.0	3.0	3.0	41.7	0.0	2 - 5
- 7		22.0	3.0	3.0	3.0	36.4	0.0	2 - 4
N926 - 2	N724aa x RZM 8931	19.0	2.0	2.0	2.0	73.7	0.0	2 - 4

NOTES: See Test B900 & B1200. The full-sib and S_1 progeny families evaluated in Test B900 were also evaluated in Test B1300. In addition, backcross progenies from the powdery mildew resistance (PMR) program were evaluated in B1300. These BC families derived from WB97 and WB242 may give the same expression of resistance to some soilborne factor under the combined conditions of rhizomania and high temperatures seen with some of the progeny families derived from C51 (R22) germplasm.

The PMR lines CP01 and CP02 with a C37, rhizomania susceptible background are nearly fully susceptible to rhizomania in tests at Salinas and Brawley (e.g. P913 and P914). When combined with *Rz*, these BC families and lines give fairly typical rhizomania resistant reactions. However, it was observed in 1998 and 1999 tests that a few plants within these lines and a few BC progenies have very good performance under the combined effects of severe rhizomania and high temperature stress (e.g. P902, P909, P912). These plants and progeny lines have reactions that are very similar to the best progeny families from C67 and C72. Test B1300 was used as a screen to identify the BC lines that have this highly resistant expression under these severe rhizomania conditions. If this desirable expression of resistance is not due to an additional factor (gene) for resistance to rhizomania, then the gene or factors that segregate fairly simply in a dominant manner must be conditioning resistance to some soilborne problem other than BNYVV. One such possible problem in these tests would be sugarbeet cyst nematode (SBCN). The same cultural practices used to develop high incidence of BNYVV would also do the same for SBCN. An examination of roots in the field did not fully support this supposition, but the roots were examined at harvest under less than ideal conditions. The source of PMR is wild beet lines (*B.vulgaris* ssp. *maritima*) WB97 and WB242. In the Netherlands 30-40 years ago, lines similar to WB242 (if not WB242) were reported to have tolerance to SBCN. In the future, BC lines and progenies found highly resistant in Tests B900 and B1300 will be evaluated under controlled conditions for reaction to SBCN. If reaction to BNYVV and SBCN can be excluded, then some other soilborne explanation will be sought.

TEST B1300. EVALUATION OF PROGENY LINES (FS & S_1) FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1999-2000

(cont.)

Variety	Description	Stand Count	Appearance		Score	% Living	Bolting	Seg Pattern
		Mean	5/18	6/07	7/06	count	%	range

Included in B1300 were eight BC families that would segregate for SBCN resistance obtained from *Beta procumbens* through B883. These BC families also segregated for *Rz* for resistance to rhizomania. In comparison to population 931 used as the rhizomania resistant recurrent parent for these BC's, several of the BC families (e.g. N925-1, N926-2) had considerably better appearance scores than the 931 recurrent parent (Test B1200, 9931). This lends some credence to the possibility that resistance to SBCN is at least a possible component in the favorable appearance of the BC, S_1, and FS families in this test.

Based upon the results in Tests B900, B1300, and B1200, the most resistant progenies will be selected, increased individually, and recombined to form highly resistant synthetics for further evaluation and improvement.

Test B1300 was treated with sulfur so powdery mildew was not severe. However, it was apparent that lines and plans with high resistance to PM occurred within the P-lines and BC-families.

Appearance scores: Prior to the June evaluation, ambient temperatures had been very hot for several weeks. These conditions caused even some families rated good in May to appear somewhat poor in June. In addition, in June it was observed that many plants were showing systemic curly top virus symptoms from late infection. This CTV infection was reducing canopy size and vigor.

Segregation pattern: On May 18, plots were rated for the range of appearance of individual plants.

TEST B1400. EVALUATION OF MONOGERM LINES AND PROGENIES FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1999-2000

64 entries x 2 reps, sequential
1-row plots, 11+2½ ft. long

Planted: September 17, 1999
Not harvested for yield

Variety	Description	Stand Count Mean	Appearance Score 5/18	Appearance Score 6/07	Appearance Score 7/06	% Living Count
Checks						
US H11	susc. check, 9-14-99	20.0	3.0	3.0	3.0	51.3
R522(Sp)	RZM-%S R322R4,...(C51)	19.5	1.0	2.5	1.5	65.5
8848M	RZM 7848M	20.0	2.5	3.0	2.5	62.5
8810M	RZM 7810NB	20.0	1.5	2.5	2.5	52.8
monogerm populations						
9808	RZM,T-O 8808-#-#(C)	19.5	3.5	4.0	3.5	37.7
9808H50	C790-15CMS x " "	19.5	3.0	3.0	2.0	78.2
9818M	RZM-ER-% 7818/2,...,M	17.5	1.5	2.5	2.5	70.0
9818HOM	8848HO x " "	19.5	2.0	3.0	2.0	66.4
9818m	RZM-ER-% 7818/2,...,mm	20.0	2.5	4.0	3.5	51.3
9835	8835mmaa x A	18.5	2.0	3.0	2.0	66.2
9838	8838mmaax A	17.0	2.5	2.5	2.0	64.7
9840	840(C)aa x A(C2)	21.0	2.0	2.5	2.0	64.3
9833	RZM 8833	21.5	3.5	4.0	3.0	59.5
9835(T-O)	RZM,T-O 8835-#(C)	21.5	3.0	3.5	3.0	50.3
9836	RZM 8836	20.0	2.0	3.0	2.5	65.0
9869	RZM-ER-% 7869NB,... (C69)	21.0	2.5	3.5	2.5	64.1
monogerm lines						
9833-5(T-O)	RZM,T-O 8833-59#(C)(C833-5)	18.5	3.0	3.5	3.0	52.4
9833-5	RZM C833-5	13.5	3.0	3.5	3.0	55.6
9831-3	RZM C831-3	14.5	2.0	1.5	1.0	82.9
9831-4	RZM C831-4	16.5	2.5	3.0	2.5	69.8
9869-6	RZM 7869-6	21.0	3.0	3.5	3.5	36.5
N965M	RZM N865(C)(galls)	18.5	2.0	3.0	3.0	41.5
99-790-15	Inc. F92-790-15	18.5	3.0	3.0	2.0	70.5
99-790-68	Inc. U88-790-68	18.5	3.0	3.5	2.5	62.8
Selfed progeny lines						
9810 - 1	RZM 8810mm⊗	17.0	1.5	2.5	2.5	50.0
- 2		7.0	3.0	3.0	3.5	58.9
- 3		10.0	3.0	3.0	3.0	40.0
- 5		15.5	2.0	3.0	2.5	67.9
- 6		12.5	3.5	4.0	3.0	65.1
- 7		2.0	2.0	3.0	4.0	100.0

NOTE: Planted on side of field where history of rhizomania was less and severity variable. See notes for Tests B900, B1200 & B1300.

TEST B1400. EVALUATION OF MONOGERM LINES AND PROGENIES FOR RESISTANCE TO RHIZOMANIA UNDER HIGH TEMPERATURES, IMPERIAL VALLEY, 1999-2000

(cont.)

Variety	Description	Stand Count Mean	Appearance Score 5/18	6/07	7/06	% Living Count
Selfed progeny lines (cont.)						
9810 - 8	RZM 8810mm⊗	10.5	3.0	4.0	3.5	50.0
- 9		11.0	3.0	3.0	2.5	69.2
-10		3.0	3.0	3.0	2.5	62.5
-11		17.0	2.5	3.5	3.0	56.9
-12		10.0	3.0	3.0	3.5	54.2
-13		18.0	3.0	3.0	3.0	62.7
-14		14.0	3.5	3.5	3.0	70.8
-15		15.5	2.0	2.5	2.0	78.3
-16		5.5	2.0	3.0	3.0	94.4
-17		16.5	2.5	3.0	3.0	53.3
9810-18	RZM8810mm⊗	14.0	3.5	3.5	3.0	55.0
-20		15.0	2.0	2.5	2.0	68.8
9848- 1	RZM 8848mm⊗	8.0	3.0	3.5	3.0	63.5
- 2		13.0	2.5	3.0	2.5	63.9
- 4		13.0	3.0	3.5	2.5	73.9
- 6		7.5	3.0	3.5	3.0	58.9
- 7		11.0	2.5	3.5	3.0	52.6
- 8		10.0	3.5	4.0	3.5	36.3
- 9		20.0	2.5	3.0	3.0	53.8
-10		7.0	2.5	3.0	3.5	66.7
-11		10.5	3.0	3.5	3.0	56.9
9815- 1	7818mm⊗	11.5	3.5	3.5	3.0	86.6
- 2		10.0	3.0	4.0	3.0	85.0
- 4		17.5	2.5	3.5	3.5	41.8
- 8		8.5	3.0	4.0	3.0	69.7
- 9		13.0	3.0	3.0	2.5	68.1
-11		17.0	3.5	4.0	3.5	41.3
9818-1B-1	RZM 8818-1Bmm⊗	13.5	3.0	3.0	2.5	80.6
-1B-3		15.5	2.5	3.0	2.0	59.2
-1B-5		15.0	3.5	3.5	3.0	44.8
-1B-6		16.0	3.0	4.0	2.5	75.3
9818-2B-4	RZM 8818-2Bmm⊗	15.0	2.0	3.5	3.5	49.3
-2B-5		14.5	2.0	3.0	3.0	65.0
-2B-6		13.0	3.5	4.0	3.0	59.5
Mean		14.8	2.7	3.2	2.8	61.8
LSD (.05)		7.7	1.2	1.1	1.2	43.7
C.V. (%)		26.0	22.6	17.1	22.1	35.4
F value		3.0**	2.0**	1.7*	1.7*	0.8NS

TEST B1000. EVALUATION OF HERBICIDE TRANSGENIC HYBRIDS FOR YIELD, IMPERIAL VALLEY, CA., 1999-2000

6 entries x 8 reps, RCB
4-row plots, 2 middle rows harvested, 27 ft. long

Planted: October 18,1999
Harvested: June 8,2000

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Root Rot %	Clean Beets %	NO3-N Mean
Checks								
B4776R	4776.9002 (4776RFA2)	11226	36.41	15.41	137	0.5	94.1	111
Phoenix	1392401 (9-10-99)	11854	40.23	14.74	150	0.2	95.7	114
Roundup-Ready								
HM115RR	Novartis Roundup-Ready	12779	45.59	14.00	141	1.6	95.2	71
HM123RR	Novartis Roundup-Ready	11915	40.90	14.56	148	0.0	94.9	101
HM124RR	Novartis Roundup-Ready	12083	42.98	14.01	149	1.6	94.0	60
Liberty-Link								
8CG9324LL	Betaseed Liberty-Link	10314	31.57	16.37	144	0.5	93.4	82
Mean		11695.2	39.61	14.85	144.8	0.7	94.6	89.8
LSD (.05)		1190.2	2.79	0.95	15.7	0.8	1.1	32.7
C.V. (%)		10.0	6.93	6.29	10.7	111.6	1.2	35.9
F value		4.1**	26.36**	7.65**	0.8NS	6.1**	4.6**	3.8*

NOTES: A test of herbicide transgenic hybrids was conducted separately from the normal official trial. All entries were treated post-plant, pre-emergence with Norton-4E. In January, RR entries were sprayed with 1qt/a Roundup Ultra; LL entry sprayed with 28oz/a Liberty. In addition all plots were hand weeded as necessary. Sulfur used for powdery mildew control. At harvest, late infection by curly top virus was evident on many plants. CT infection probably reached 100%. Entries 2,4, and 5 appeared to be most affected. Root rot appeared to be due to Rhizopus. At harvest, all entries had turned pale yellow.

TEST B1000. EVALUATION OF HERBICIDE TRANSGENIC HYBRIDS FOR YIELD, IMPERIAL VALLEY, CA., 1999-2000

(cont.)

Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH_2-N ppm	Impur. Value
Checks								
B4776R	9651	265	86.0	1575	540	2137	926	14382
Phoenix	10151	253	85.6	1703	532	2224	864	14008
Roundup-Ready								
HM115RR	10911	239	85.3	1868	557	2350	792	13648
HM123RR	10034	245	84.2	1880	608	2491	931	15348
HM124RR	10264	238	84.8	1819	608	2344	843	14142
Liberty-Link								
8CG9324LL	9066	288	87.9	1248	408	2065	820	13143
Mean	10013.0	254.6	85.6	1682.2	542.1	2268.6	862.5	14111.7
LSD (.05)	1131.9	20.5	2.6	311.9	103.6	209.3	232.8	2318.0
C.V. (%)	11.1	7.9	3.0	18.3	18.8	9.1	26.6	16.2
F value	2.5NS	7.2**	2.1NS	5.0**	4.2**	4.6**	0.5NS	0.9NS

CURLY TOP EVALUATION, SALINAS ENTRIES, BSDF NURSERY
KIMBERLY, ID, 2000

216 entries x 3 replications, sequential — Not harvested for yield
144 entries x 3 reps, 2-row plots, 12 ft. long
72 entries x 3 reps, 1-row plots, 12 ft. long

Variety	Description	Stand Count No.	BSDF 1st Score 08/21	BSDF 2nd Score 09/05
US H11	1999 production, 11-3-99	14.5	5.0	5.5
WS-PM9	HM-WS-PM9, 4-18-95	14.5	4.5	4.5
B4776R	Betaseed	16.0	6.0	7.7
B4035R	Betaseed	12.0	5.3	6.7
B4430R	L4430.8052, 3-10-99	19.5	6.5	8.5
SS-432R	Spreckels, 2-8-99	15.5	5.5	6.5
Rifle	Spreckels	10.0	7.0	7.0
Alpine	Spreckels	11.0	6.0	6.7
Phoenix	Spreckels	16.0	6.7	7.3
Monohikari	Seedex	22.5	7.5	9.0
US H11	old (resist. check)	16.5	5.0	5.5
US H11	1999 production, 11-3-99	17.0	4.5	5.0
R778H8	F82-546H3 x C78	11.0	5.0	5.3
R978H50	C790-15CMS x C78	11.0	5.0	5.3
R980H50	C790-15CMS x C80	13.0	5.3	6.3
CR911H50	C790-15CMS x CR811(C)(CR09,10)	19.0	5.0	6.0
CR911H6	(C790-15CMS x C833-5) x CR811(C)	16.5	5.0	5.0
CR911H35	8835aa x CR811(C)	17.0	5.3	6.3
9931H50	C790-15CMS x RZM 8931	14.0	5.3	6.3
9931H5	C833-5aa x RZM 8931	10.5	5.5	6.0
9931H35	8835aa x RZM 8931	17.0	5.0	5.7
9941H50	C790-15CMS x 941(C)	18.5	5.0	5.0
9941H6	(C790-15CMS x C833-5) x 941(C)	15.5	5.0	5.0
9941H35	8835aa x 941(C)	18.0	5.3	5.7
9933H50	C790-15CMS x RZM 8933	12.5	5.0	6.0
9933H35	8835aa x RZM 8933	19.0	6.0	6.7
9926H50	C790-15CMS x RZM 8926	21.0	5.0	6.0
9926H35	8835aa x RZM 8926	20.5	4.5	5.5
Y967H50	C790-15CMS x RZM-ER-% Y767(C67)	19.0	5.3	5.7
R976-89H50	C790-15CMS x R76-89-5/18	14.0	5.7	6.0
US H11	1999 production, 11-3-99	17.0	4.7	5.0
WS-PM9	HM-WS-PM9, 4-18-95	19.0	4.3	4.7
Y969H50(Iso)	C790-15CMS x RZM-ER-% Y769,(C69)	19.5	5.5	5.5
Y969H3	97-562HO x Y869, (C69)	13.5	5.5	5.5
Y969H4	C831-3aa x Y869	20.5	6.5	7.5
Y969H5	C833-5aa x Y869	15.5	5.0	5.5

CURLY TOP EVALUATION, SALINAS ENTRIES, BSDF NURSERY
KIMBERLY, ID, 2000

(cont.)

Variety	Description	Stand Count No.	BSDF 1st Score 08/21	BSDF 2nd Score 09/05
Y969H6	(C790-15CMS x C833-5) x Y869	13.0	5.5	6.0
Y969H12	C833-12aa x Y869	16.0	5.0	6.0
Y969H27	C833-4HO x Y869	17.5	5.0	6.0
Y969H29	C829-3aa x Y869	14.0	5.7	6.3
Y969H37	C306/2CMS x Y869	7.0	5.3	5.7
Y969H45	C867-1HO x Y869	16.0	5.0	5.5
Y969H46	7869-6HO x Y869	13.0	6.0	6.7
Y969H33	8833aa x Y869	10.5	5.0	5.5
Y969H35	8835aa x Y869	13.0	5.0	6.0
Y969H36	8836aa x Y869	12.0	5.0	5.7
Y769H8	F82-546H3 x C69	12.0	4.7	5.0
Y769H39	C762-17CMS x C69	10.0	4.5	4.5
Multigerm, O.P. Lines				
Monohikari	Seedex	17.0	8.3	9.0
US H11	1999 production, 11-3-99	17.5	5.0	5.0
97-US22/3	Inc. Y009 (US 22/3)	19.5	4.0	5.0
99-C37	Inc. U86-C37, (C37)	15.0	4.3	4.7
97-SP22-0	Inc. SP7622-0 (SP6822-0)	15.0	7.0	7.3
R976-89-18	Inc. C76-89-18	17.0	6.3	7.3
99-C31/6	Inc. F86-31/6, (C31/6)	20.0	6.7	7.7
99-C46/2	Inc. U86-46/2, (C46/2)	17.5	5.5	5.5
99-EL02/04	RZM 98-EL-02/04	12.0	7.7	8.3
99-FC123M	RZM-ER-% FC1,2,3	14.0	4.7	5.7
P907	RZM-PMR P807,8	17.0	5.7	5.3
P909	RZM-PMR P809,10	15.0	5.3	5.7
P911	RZM-PMR P811	12.0	5.7	6.0
P913	PMR P813, CP01, WB97	23.0	4.0	5.0
P914	PMR P814, CP02, WB242	24.5	5.0	5.5
P915	RZM-PMR P815, 16	15.5	5.5	5.0
R926	RZM R826, (C26)	19.0	4.0	5.3
R927	RZM R827, (C27)	19.0	5.7	6.3
R936	RZM-ER-% R736, (C79-8)	16.0	5.0	6.0
R940	RZM-ER-% R740, (C79-#)	24.0	4.0	4.0
R943	RZM-ER-% R643	18.5	6.0	7.0
R954	RZM-ER-% R754, R746	19.5	6.0	7.0
R970	RZM-ER-% R770	15.0	6.7	7.7
R978	RZM-ER-% R778, (C78)	17.0	5.7	6.3

CURLY TOP EVALUATION, SALINAS ENTRIES, BSDF NURSERY
KIMBERLY, ID, 2000

(cont.)

Variety	Description	Stand Count No.	BSDF 1st Score 08/21	BSDF 2nd Score 09/05
Multigerm, O.P. Lines (cont.)				
R980	RZM-ER-% R780/2,…,(C80)	16.0	7.0	7.0
Y969(Iso)	RZM-ER-% Y769, (C69)	13.0	6.5	7.0
Y967	RZM-ER-% Y767, (C67)	17.0	6.7	7.3
Y971	RZM-ER-% Y771,	14.0	6.0	7.3
Y975	RZM Y875	16.0	6.0	7.0
US H11	1999 production, 11-3-99	20.5	4.0	4.5
Monohikari	Seedex	13.5	9.0	9.0
WS-PM9	HM-WS-PM9, 4-18-95	16.0	4.3	5.3
Multigerm, S^f,Aa Populations & Lines				
9931	RZM 8931aa x A,(*Rz* VY base popn)	15.0	5.3	5.7
9924	RZM 8924aa x A,(*Rz*,VY)	18.0	5.7	6.7
9932	RZM 8932aa x A,(*Rz*,CT)	16.0	5.0	5.3
9933	8933aa x A,(*Rz*,Root Aphid)	16.0	4.0	6.0
9934	RZM 8934(C),(*Rz*,R22,VY)	17.5	5.0	5.5
9941	941(C)aa x A,(*Rz*,VY)	12.0	5.3	6.0
9926	8926aa x A,(R22)	12.0	5.7	6.3
P912	PMR-RZM P812, *Rz*,PMR,NR)	8.0	5.0	6.0
9719*Bm*	Inc. 6719 (C719*Bm*),(BMVR)	18.0	4.5	5.5
Z925	RZM-ER-% Z725(C), (*Rz*,%S)	13.5	6.5	7.5
N972	RZM N872(C), (*Rz*,NR)	13.5	6.5	8.0
CR909-1	RZM R709-1, (*Rz*,CR) (CR09-1)	12.0	6.0	7.0
CR910	RZM R710,…,(*Rz*,CR) (CR10)	9.0	6.3	7.3
CR911(C)	RZM CR811(C)aa x A,(CR09,CR10)	18.0	5.7	6.7
CR912	RZM-ER-% CR711,712	12.0	5.7	7.0
9918-21	RZM 8918-21	12.5	5.5	8.0
Increases Selected S_1 MM Progeny				
9924-2	Inc. 7924-2	7.5	5.0	6.0
9924-6	Inc. 7924-6	12.0	5.0	6.0
9924-10	Inc. 7924-10	10.0	5.0	6.0
9924-74	Inc. 7924-74%	12.0	5.3	6.3
9924-77	Inc. 7924-77	16.0	5.0	6.0
9924-78	Inc. 7924-78	7.0	6.0	6.0
9924-114	Inc. 7924-114	16.0	5.0	6.0
9927-4	Inc. 7927-4VY	9.0	5.7	6.3
9927-17	Inc. 7927-17VY	14.0	4.3	4.7
9928-34	Inc. 7928-34	19.0	6.5	7.0
9928-107	Inc. 7928-107	15.0	5.5	6.5
9929-4	Inc. 7929-4VY	12.0	8.0	7.0

CURLY TOP EVALUATION, SALINAS ENTRIES, BSDF NURSERY
KIMBERLY, ID, 2000

(cont.)

Variety	Description	Stand Count No.	BSDF 1st Score 08/21	BSDF 2nd Score 09/05
Increases Selected S_1 MM Progeny (cont.)				
9929-9	Inc. 7929-9VY	13.5	5.5	7.0
9929-45	Inc. 7929-45VY	16.0	7.3	9.0
9929-47	Inc. 7929-47VY	13.0	6.3	7.3
9929-48	Inc. 7929-48VY	19.0	7.5	8.5
9929-56	Inc. 7929-56VY	22.0	8.0	9.0
9929-62	Inc. 7929-62	13.0	6.0	7.0
9930-17	Inc. 7930-17VY	18.0	5.3	6.0
9930-32	Inc. 7930-32	10.0	5.5	6.0
9930-35	Inc. 7930-35	12.5	4.5	5.5
9931-18	Inc. 7931-18	11.0	4.7	5.7
9931-24	Inc. 7931-24	8.0	6.0	7.0
9931-29	Inc. 7931-29	11.5	5.0	6.0
Monogerm Populations & Lines				
N965M	RZM N865,6,7 (galls)	13.0	6.0	7.0
9833	RZM 8833	12.0	5.7	6.3
9835 T-O	RZM,T-O 8835-#(C)	13.0	4.5	6.0
9835	8835mmaa x A	13.5	5.5	6.5
9836	RZM 8836	13.0	6.0	7.0
9838	8838mmaa x A	10.5	5.5	6.0
9840	840(C)mmaa x A (T-O,CTR,NB)	11.0	4.7	5.7
9869	RZM-ER-% 7869NB (C869)	12.5	5.0	5.5
9808	RZM,T-O 8808-#(C)	12.0	4.5	5.5
9818	RZM-ER-% 7818,7848	12.0	5.3	6.0
99-790-15	Inc. 92-C790-15	18.0	5.5	6.0
99-790-68	Inc. U88-C790-68	8.0	5.5	7.0
9829-3	RZM 8829-3-#(C), (C829-3)	9.0	5.3	6.3
9831-3	RZM 8831-3, (C831-3)	17.5	6.0	7.0
9831-4	RZM 8831-4, (C831-4)	14.0	5.5	6.5
9833-5T-O	RZM,T-O 8833-5-#(C), (C833-5)	11.5	5.5	7.0
9833-5	RZM 8833-5, (C833-5)	9.0	5.5	5.5
9833-12	RZM 8833-12, (C833-12)	13.0	5.0	6.0
9867-1	RZM 7867-1m, (C867-1)	16.5	5.5	6.5
9869-6	RZM 7869-6 (barbed?)	10.5	5.0	6.0
8911-4-10M	RZM-ER-% 6911-4-10	19.5	4.5	6.0
6718	Inc. U83-718 (C718)	10.0	4.0	6.0
6762-17	Inc. 0762-17 (C762-17)	5.0	4.0	4.0
6562	Inc. F82-562 (C562)	11.5	4.0	5.0

CURLY TOP EVALUATION, SALINAS ENTRIES, BSDF NURSERY
KIMBERLY, ID, 2000

(cont.)

Variety	Description	Stand Count No.	BSDF 1st Score 08/21	BSDF 2nd Score 09/05
Full-sib progeny				
R978 - 1	RZM R878% PX, (C78)	6.0	5.5	6.0
- 2		6.0	6.5	8.0
- 3		6.0	7.0	8.0
- 4		7.0	6.0	8.0
- 5		9.0	6.0	7.0
- 6		5.0	4.0	7.0
- 7		7.5	6.5	6.5
- 8		12.0	5.0	6.0
- 9		7.0	6.5	6.0
-10		7.0	6.5	7.0
-11		9.0	6.5	7.5
-12		8.0	6.5	7.0
R980 - 1	RZM R880 PX, (C80)	7.5	7.0	7.5
- 2		9.0	7.0	7.0
- 3		6.0	6.3	7.0
- 4		8.0	5.0	7.0
- 5		6.0	7.3	7.7
- 6		11.0	7.0	7.0
- 7		8.0	6.5	8.0
- 8		8.5	7.5	7.5
- 9		9.0	7.0	8.0
-10		6.0	6.0	8.0
-11		-.-	-.-	-.-
-12		-.-	-.-	-.-
Y968 - 1	RZM Y868 PX	-.-	-.-	-.-
- 2		-.-	-.-	-.-
- 3		9.5	5.0	6.5
- 4		7.0	6.7	7.0
- 5		10.0	7.0	7.0
- 6		10.0	7.0	7.0
Y969 - 1	RZM Y869 PX, (C69)	6.5	6.0	7.0
- 2		6.0	6.5	7.0
- 3		9.0	6.5	8.0
- 4		8.5	6.5	8.0
- 5		5.0	8.0	8.0
- 6		10.0	7.0	8.0

CURLY TOP EVALUATION, SALINAS ENTRIES, BSDF NURSERY
KIMBERLY, ID, 2000
(cont.)

Variety	Description	Stand Count	BSDF 1st Score	BSDF 2nd Score
		No.	08/21	09/05
S_1 progeny lines				
Z931 - 1	RZM Z831⊗	-.-	-.-	-.-
- 2		8.0	5.0	7.0
- 3		9.0	6.0	7.0
- 4		-.-	-.-	-.-
- 5		9.0	8.0	8.0
- 6		7.0	6.7	7.3
- 7		11.0	7.0	8.0
- 8		6.0	7.0	8.0
- 9		7.5	7.0	7.5
-10		9.0	6.7	8.3
-11		-.-	-.-	-.-
-12		-.-	-.-	-.-
9931 - 1	RZM 8931⊗	9.0	5.0	6.0
- 2		8.0	6.0	6.0
- 3		-.-	-.-	-.-
- 4		8.0	6.5	8.0
- 5		-.-	-.-	-.-
- 6		7.0	5.5	6.5
- 7		10.0	6.0	6.0
- 8		5.0	5.5	6.0
-201	RZM 7931⊗	10.0	4.0	4.0
-202		7.5	5.5	5.0
-203		11.0	4.0	5.0
-204		12.0	4.0	5.0
Half-sib progeny				
CR909-1-1(Sp)	R709-1aa x CR811(C)	9.0	5.0	5.0
-1-2		7.0	5.0	5.0
-1-3		5.5	5.0	5.5
-1-4		7.5	5.0	5.5
CR910-1(Sp)	R710aa x CR811(C)	10.0	5.0	6.0
-2		6.0	5.7	6.0
-3		10.0	6.0	6.3
-4		8.0	6.0	7.0
CR913-1(Sp)	CR813aa x CR811(C)	8.0	6.5	6.5
-2		10.0	5.0	6.0
-3		13.0	4.0	6.0
-4		6.5	5.5	6.5

NOTES: Cultivation caused moderate damage to many plots. Plots with fewer than 5 plants were considered missing. Means were calculated for the remaining 1,2, or 3 repetitions.

TEST 4300. ERWINIA/POWDERY MILDEW EVALUATION OF LINES AND POPULATIONS, SALINAS, CA., 2000

80 entries x 3 reps., sequential
1-row plots, 17'6" ft. long

Planted: April 12, 2000
Inoc. *Ecb*: July 18, 2000
Ecb scored: October 31, 2000

Variety	Description	Powdery Mildew 10/12	Stand Count No.	Harvest Count No.	Erwinia Rating DI	%R
Multigerm, open-pollinated						
US H11	9-14-99 (new)	7.7	32.3	33.7	5.8	78.3
E740	Inc. E840 (Susc.check = C40)	7.3	28.3	28.7	75.8	11.2
97-US22/3	Inc. Y009 (US22/3)	7.3	31.0	32.0	20.8	53.9
97-US75	Inc. 268 (US75)	7.3	31.0	32.0	19.2	63.4
99-C37	Inc. U86-37 (C37)	7.3	30.0	30.3	11.6	71.0
99-C46/2	Inc. U86-46/2 (C46/2)	6.0	27.3	28.0	10.9	60.8
R778(Iso)	RZM-ER R578,… (C78)	4.3	27.3	25.7	6.4	77.9
R978	RZM-ER-% R778,% (C78)	3.3	26.7	28.3	9.1	76.1
R880	RZM R780 (C80)	5.7	28.3	32.3	6.2	79.9
R980	RZM-ER-% R780/2,… (C80)	5.0	29.0	29.7	6.4	74.0
R970	RZM-ER-% R770	5.7	28.7	28.3	5.2	77.3
99-C31/6	Inc. F86-31/6	6.0	30.0	31.0	6.2	83.7
R881(Iso)	RZM R776, R781, R681 (C82)	4.7	26.7	26.7	5.7	83.4
Y869(Iso)	RZM Y769, (C69)	4.3	24.0	25.0	4.8	81.7
Y969(Sp)	RZM Y869	3.7	29.3	31.0	2.1	89.0
Y969(Iso)	RZM-ER-% Y769, (C69)	4.7	28.0	28.3	3.8	85.9
R876-89-5NB	RZM-%S R576-89-5NB(C76-89-5)	3.3	30.0	30.7	4.0	91.7
R876-89-18	Inc. R576-89-18,NB(C76-89-18)	5.3	25.7	25.3	10.2	76.3
R976-89(Sp)	R876-89-5rr x R576-89-18	4.3	29.3	28.0	11.5	79.6
US H11	9-14-99	8.3	31.0	29.3	6.9	72.5
E740	Inc. E840 (susc. ck.)	7.3	32.0	30.7	80.3	10.7
99-FC-123M	RZM-ER-% FC-1,2,3	6.7	30.7	29.0	14.0	74.0
99-EL-02/04	RZM 98-EL-02,4	5.7	28.3	28.7	7.8	75.1
R943	RZM-ER-% R643	4.7	30.0	31.7	13.8	66.5
Y867	RZM Y767, (C67)	4.0	29.7	29.0	2.0	86.1
Y967	RZM-ER-% Y767 (Iso)	5.0	28.7	30.0	2.4	87.8
Y971	RZM-ER-% Y771	6.0	29.7	30.0	9.9	75.5
Y975	RZM Y875	5.7	28.0	26.7	7.1	77.1
R954	RZM-ER-% R754, R746	6.7	31.3	30.7	12.1	69.7
R940	RZM-ER-% R740	5.3	29.0	27.7	4.6	76.6
R936	RZM-ER-% R736 (C79-8)	5.7	29.7	30.7	6.4	76.0
R928	RZM R728 (C79-4)	5.7	28.7	29.0	28.2	59.8

TEST 4300. ERWINIA/POWDERY MILDEW EVALUATION OF LINES AND POPULATIONS, SALINAS, CA., 2000

(cont.)

Variety	Description	Powdery Mildew 10/12	Stand Count No.	Harvest Count No.	Erwinia Rating DI	Erwinia Rating %R
Multigerm, open-pollinated (cont.)						
R926	RZM R826, (C26)	6.0	29.3	31.7	10.6	64.4
R927	RZM R827, (C27)	4.7	31.0	31.0	5.5	81.9
P907	RZM-PMR P807,8	3.7	29.0	29.3	21.9	53.1
P909	RZM-PMR P809,10	4.7	32.7	33.0	19.1	60.9
US H11	9-14-99	8.0	30.7	29.7	7.6	78.2
E740	Inc. E840 (susc.ck)	7.0	29.0	28.3	70.2	18.9
P913	PMR P813, CP01 (WB97)	5.7	26.0	26.3	10.5	72.8
P914	PMR P814, CP02 (WB242)	6.3	30.7	30.7	4.9	88.3
P911	RZM-PMR P811	5.3	30.0	30.3	4.5	86.9
P915	RZM-PMR P815,6	5.0	31.0	31.0	5.7	90.5
99-C37	Inc. U86-37, (C37)	7.7	31.0	30.3	2.0	93.4
E740	Inc. E840 (susc. ck. = C40)	7.7	29.0	28.0	72.8	18.0
Multigerm, S^f, Aa Population and Lines						
8931	RZM 7931aa x A, (popn-931)	5.0	31.7	32.3	3.6	88.6
9931	RZM 8931aa x A, (popn-931)	4.3	29.7	31.3	5.3	79.6
9924	RZM 8924aa x A (VY)	4.7	29.7	29.7	2.9	89.9
9932	RZM 8932aa x A (CT)	5.7	30.3	30.7	14.7	66.7
9933	8933aa x A (Root aphid)	5.0	30.0	32.3	2.4	88.6
9941	941(C)aa x A (VY)	4.3	30.7	30.7	2.4	91.5
Z925	RZM-ER-% Z725(C) (%S polish)	6.0	28.7	28.7	8.3	74.8
9926	RZM 8926aa x A (*Bvm*)	4.7	28.0	29.0	0.5	97.8
9934	RZM 8934(C),(R76-89-5 x 7934)	5.3	31.0	31.3	4.3	92.3
P912	PMR-RZM P812	3.3	30.0	31.0	1.4	92.6
CR811	RZM CR711,(CR09,10)	4.7	29.7	30.3	3.6	86.4
CR812	RZM CR712	4.7	32.0	32.7	5.8	81.7
CR912	RZM-ER-% CR711,CR712	5.7	27.7	29.0	5.7	79.5
CR911(Sp)	CR811(C)aa x A(C) (CR09,10)	6.7	30.0	30.7	4.5	76.1
CR910	RZM R710,R709-9,… (CR10)	6.3	25.7	24.3	1.7	88.9
CR909-1	RZM R709-1 (CR09-1)	4.0	29.3	30.3	4.8	86.9
9719*Bm*	Inc. 6719, (C719*Bm*)	3.0	28.7	27.7	4.4	82.9
N972	RZM N872,B,(WB-NR)	5.7	27.7	27.3	3.4	86.6
E740	Inc. E840 (susc. ck. = C40)	7.0	27.7	25.0	84.8	6.2
US H11	9-14-99	8.0	30.0	28.3	13.6	62.2
Monogerm, S^f, Aa Populations						
N965M	RZM N865,6,7 (galls)	4.7	27.3	28.0	10.6	77.1
9833	RZM 8833	7.0	32.0	31.3	5.2	87.0
9835(T-O)	RZM,T-O 8835-#(C)	5.3	30.0	29.7	19.2	61.8
9835	RZM 8835mmaa x A	7.0	31.3	32.7	26.5	59.7

TEST 4300. ERWINIA/POWDERY MILDEW EVALUATION OF LINES AND POPULATIONS, SALINAS, CA., 2000

(cont.)

Variety	Description	Powdery Mildew 10/12	Stand Count No.	Harvest Count No.	Erwinia Rating DI	Erwinia Rating %R
Monogerm, S^f, Aa Populations (cont.)						
9836	RZM 8836	7.3	33.3	33.7	6.0	71.1
9838	RZM 8838mmaa x A	6.7	30.3	30.7	7.7	80.7
9869	RZM-ER-% 7869NB, (C69)	6.7	32.0	31.7	21.3	58.0
9840	840(C)mmaa x CTR, T-O, NB	7.0	32.0	32.7	10.4	72.3
9818M	RZM-ER-% 7818/2,…	5.0	27.0	27.3	17.3	62.4
9808	RZM,T-O 8808-#-#(C)	7.0	29.7	29.3	15.0	61.7
E840	Inc. E840 (susc. check)	7.3	28.7	26.3	82.4	5.1
US H11	9-14-99	7.3	30.0	28.7	10.2	73.1
N724	Inc. N623,4 (galls)	5.3	30.3	29.7	5.8	79.8
N730	Inc. N629,30 (galls)	4.3	26.0	25.0	9.1	77.0
7747	Inc. 5747 (A,aa)	7.3	27.0	27.7	2.4	89.1
8911-4-10M	RZM-ER-%6911-4-10,(C911-4-10)	3.3	28.7	29.0	2.8	87.5
Mean		5.7	29.4	29.6	13.6	72.7
LSD (.05)		1.8	4.0	4.6	8.2	16.9
C.V. (%)		19.3	8.5	9.7	37.4	14.4
F value		4.4**	1.6*	1.7**	43.4**	11.2**

NOTES: Powdery mildew not controlled but severity remained moderate. Test became low in nitrogen and combination of canopy damage during *Ecb* inoculation and low nitrogen status resulted in only moderate development. Powdery mildew scored on a scale of 0 to 9, where 9 = 90-100% of leaf area visible infected or covered with mildew.

Erwinia inoculation on July 18, 2000, using wound-inoculation technique. Erwinia rot was scored on a scale of 0,7,25,50,75,93, and 100% rot on an individual root basis. Disease index = average rot per root. %R = percent resistant where class 0 was considered resistant and 7-100% were considered susceptible. Disease development was moderate, but based upon the checks (USH11 = resistant, E740 = susceptible), representative of varietal disease reaction.

TEST 4400. ERWINIA/POWDERY MILDEW EVALUATION OF MULTIGERM,S^f,Aa PROGENY LINES, SALINAS, CA., 2000

40 entries x 3 reps., sequential
1-row plots, 17'6" ft. long

Planted: April 12, 2000
Inoc *Ecb*: July 18, 2000
Ecb scored: November 1, 2000

Variety	Description	Powdery Mildew	Stand Count	Harvest Count	Erwinia Rating	
		10/12	No.	No.	DI	%R
Commercial Hybrids						
Beta 4430R	4430.9041 (9-8-99)	2.3	34.0	34.3	11.3	71.4
Beta 4776R	2000	2.3	33.3	33.3	13.7	71.2
Beta 4419R	1-19-99,	6.3	31.3	33.7	15.5	71.7
Alpine	X612401, 1999	5.0	32.0	32.7	11.6	69.8
US H11	9-14-99	7.3	28.3	27.3	8.7	75.2
E740	Inc. E840 (susc. check)	6.0	29.3	28.7	85.5	9.6
Phoenix	1999	4.3	32.7	32.0	18.2	61.1
Rifle	1999	5.0	28.7	29.7	19.9	60.4
Multigerm, S^f, Aa Lines						
8918-12	RZM-ER-% 6918-12	1.3	26.0	28.0	1.3	86.5
8913-70	RZM-ER-% 6913-70(C913-70)	3.3	31.7	31.0	1.7	88.2
8927-29	Inc. 6927-29 (A,aa)	1.7	28.3	30.3	7.6	74.6
8929-112	Inc. 6929-112 (A,aa)	3.0	30.7	32.3	4.8	77.3
8929-114	Inc. 6929-114 (A,aa)	2.0	26.7	27.7	32.2	50.5
8930-19	Inc. 6930-19 (A,aa)	2.3	31.0	32.0	5.4	81.1
Z825-9	Inc. Z625-9 (A,aa)	2.3	28.3	28.7	18.4	52.1
9924-2	Inc. 7924-2 (A,aa)	2.3	24.7	25.7	2.1	86.3
9924-6	Inc. 7924-6	2.7	26.7	26.3	11.3	66.4
9924-10	Inc. 7924-10	3.7	27.3	28.0	2.8	82.2
9924-74	Inc. 7924-74%	4.0	27.7	27.7	3.1	79.8
9924-77	Inc. 7924-77	2.7	29.7	29.7	5.7	78.6
9924-78	Inc. 7924-78	2.7	27.0	31.0	5.1	79.9
9924-114	Inc. 7924-114	2.3	24.0	24.7	2.7	88.4
9927-4	Inc. 7927-4VY	5.0	28.0	27.3	6.4	68.3
9927-17	Inc. 7927-17VY	3.7	26.3	26.0	2.2	84.8
9928-34	Inc. 7928-34	5.0	29.0	29.3	4.1	78.1
9928-107	Inc. 7928-107	2.3	29.0	29.3	1.4	90.8
E740	Inc. E840 (susc. check)	7.0	28.3	28.3	85.6	4.8
9929-9	Inc. 7929-9VY	2.3	27.7	29.0	9.2	73.3
9929-45	Inc. 7929-45VY	3.0	25.3	27.0	15.1	71.3
9929-47	Inc. 7929-47VY	5.7	27.7	26.0	4.6	83.8
9929-48	Inc. 7929-48VY	2.7	27.7	29.0	12.7	59.6
9929-56	Inc. 7929-56VY	2.7	26.7	28.7	3.5	84.1

TEST 4400. ERWINIA/POWDERY MILDEW EVALUATION OF MULTIGERM, S^f, Aa PROGENY LINES, SALINAS, CA., 2000

(cont.)

Variety	Description	Powdery Mildew 10/12	Stand Count No.	Harvest Count No.	Erwinia Rating DI	Erwinia Rating %R
Multigerm, S^f, Aa Lines (cont.)						
9929-62	Inc. 7929-62	1.7	27.0	26.7	9.4	69.9
9930-17	Inc. 7930-17VY	4.0	30.0	32.0	3.1	80.9
9930-32	Inc. 7930-32	2.7	27.0	26.3	19.0	58.5
9930-35	Inc. 7930-35	3.0	32.3	32.7	19.1	48.3
9931-18	Inc. 7931-18	1.3	25.7	24.7	4.0	78.8
9931-24	Inc. 7931-24	1.3	28.0	27.7	3.2	80.5
9931-29	Inc. 7931-29	3.3	27.7	28.3	8.5	74.0
9929-4	Inc. 7929-4VY	2.0	29.3	27.7	8.1	74.3
Mean		3.3	28.6	29.0	12.7	70.7
LSD (.05)		2.0	4.6	4.7	9.6	18.8
C.V. (%)		36.8	9.9	10.0	46.5	16.4
F value		4.9**	2.1**	2.3**	28.6**	7.4**

NOTES: See test 4300. Also see tests 2100, 200, 6300; 3000, 100, 6900, B300, and B600.

TEST 4500. ERWINIA/POWDERY MILDEW EVALUATION OF MONOGERM LINES, SALINAS, CA., 2000

40 entries x 3 reps., sequential
1-row plots, 17'6" ft. long

Planted: April 12, 2000
Inoc. *Ecb*: July 18, 2000
Scored *Ecb*: November 1, 2000

Variety	Description	Powdery Mildew 10/12	Stand Count No.	Harvest Count No.	Erwinia Rating DI	Erwinia Rating %R
Monogerm lines						
9833	RZM 8833 (A,aa)	7.0	29.3	29.0	3.1	86.0
9833-5TO	RZM,T-O 8833-5-#(C)(C833-5)	4.7	32.0	32.0	2.6	87.5
9833-5(T-O)HO	RZM 8833-5H50 x RZM,T-O 8833-5-#(C)	4.0	32.7	32.3	4.5	83.3
9833-5	RZM 8833-5, (C833-5)	3.7	29.7	30.3	8.4	74.9
9833-5HO	RZM 8833-5H50 x RZM,T-O 8833-5-#(C)	6.0	30.7	30.7	7.3	74.0
9833-10	RZM 7833-10⊗	2.3	27.7	29.0	64.0	16.0
9833-12	RZM 8833-12, (C833-12)	7.3	33.0	30.0	25.3	58.6
9835-T-O	RZM,T-O 8835-#(C)	6.7	30.0	29.0	25.5	51.0
US H11	9-14-99	8.0	30.3	31.0	3.5	87.0
E740	Inc. E840 (susc.check = C40)	7.0	31.3	32.7	80.0	14.5
9835	8835mmaa x A	6.7	30.3	28.7	12.4	65.7
9835HO	8835HOmm x "	5.7	30.0	31.3	10.0	70.8
9829-3	RZM 8829-3-#(C) (C829-3)	5.3	33.7	33.7	12.8	67.2
9831-3	RZM 8831-3, (C831-3)	2.0	31.3	29.3	20.4	49.9
9831-4	RZM 8831-4, (C831-4)	6.3	33.3	33.3	20.9	59.4
9831-4-7	RZM 7831-4-7⊗	5.3	33.0	32.0	17.5	65.3
9831-4-10	RZM 7831-4-10⊗	6.0	32.0	32.0	23.2	53.6
9836	RZM 8836	6.7	33.7	33.3	11.4	69.1
9838	8838mmaa x A	5.7	30.7	31.0	11.4	72.9
9840	840(C)aa x A	6.0	34.0	33.7	13.4	60.7
9808	RZM,T-O 8808-#(C)	6.0	33.7	34.7	18.2	65.1
9867-1	RZM 7867-1m, (C867-1)	4.0	32.0	32.7	22.1	55.0
9869-6	RZM 7869-6	6.3	33.0	33.0	2.5	91.6
9869	RZM-ER-% 7869NB, (C869)	6.0	33.3	34.3	15.6	64.6
99-790-15	Inc. F92-790-15, (C790-15)	2.7	32.3	31.7	11.5	67.3
99-790-68	Inc. U88-790-68, (C790-68)	3.0	33.3	31.7	31.2	48.3
6546	Inc. F82-546 (C546)	6.3	27.0	23.0	10.2	71.1
6762-17	Inc. 0762-17,2762-17 (C762-17)	2.7	24.0	25.0	67.9	25.3

TEST 4500. ERWINIA/POWDERY MILDEW EVALUATION OF MONOGERM LINES, SALINAS, CA., 2000

(cont.)

Variety	Description	Powdery Mildew	Stand Count	Harvest Count	Erwinia Rating	
		10/12	No.	No.	DI	%R
Topcross hybrids with monogerm lines						
Y969H50(Iso)	C790-15CMS x RZM-ER-% Y769	4.3	31.0	29.7	17.6	63.7
Y969H3	97-562HO x Y869 (C69)	5.3	31.3	31.3	11.7	71.6
Y869H4	C831-3aa x Y869	1.7	26.0	25.0	4.3	78.0
Y869H5	C833-5aa x Y869	2.0	27.3	27.7	8.5	75.6
US H11	9-14-99	7.3	30.7	29.7	11.7	68.8
E740	Inc. E840 (C40)	6.7	29.7	26.3	77.1	7.9
Y869H12	C833-12aa x Y869	5.7	28.3	26.3	12.8	73.3
Y869H27	C831-4HO x Y869	4.0	30.0	29.3	10.1	73.6
Y869H29	C829-3aa x Y869	3.3	29.7	30.0	2.7	80.7
Y869H45	C867-1HO x Y869	3.7	27.3	27.7	6.1	77.1
Y869H46	7869-6HO x Y869	4.3	30.0	30.3	5.2	82.6
Y869H50 (Sp)	C790-15CMS x Y869	3.3	29.7	28.7	6.1	78.8
Mean		5.0	30.7	30.3	18.3	64.7
LSD (.05)		1.7	4.2	4.7	10.3	19.8
C.V. (%)		21.2	8.3	9.6	34.6	18.9
F value		7.8**	2.5**	2.6**	29.0**	7.7**

NOTES: See test 4300.

TEST 4200. CODED POWDERY MILDEW TEST, SALINAS, CA., 2000

48 entries x 6 reps., sequential
1-row plots, 11 ft. long

Planted: April 12, 2000
Not harvested for yield

Code No.	Variety	Company	Stand Count Mean	Powdery Mildew Score 08/17	08/21	08/28	09/05	09/11	09/18	Mean
PM- 1	99HX924	Spreckels	18.3	2.5	3.0	4.3	5.8	6.0	6.5	4.7
- 2	7CG7322	Betaseed	19.0	2.7	3.2	4.7	5.8	6.0	6.3	4.8
- 3	99HX923	Spreckels	19.0	2.7	2.8	4.5	5.8	6.0	6.7	4.8
- 4	4KJ0164	Betaseed	19.2	1.7	1.8	3.2	4.8	5.5	5.7	3.8
- 5	Rifle	Spreckels	18.3	2.3	2.2	4.3	6.2	6.3	6.5	4.6
- 6	7KJ0191	Betaseed	19.2	3.0	2.7	5.3	7.0	7.0	7.0	5.3
- 7	Summit	Spreckels	19.5	2.3	3.0	4.8	6.2	6.3	6.7	4.9
- 8	US H11	Standard	20.5	3.7	5.0	6.3	7.7	7.7	7.8	6.4
- 9	Beta 4300R	Betaseed	18.7	3.0	4.0	6.3	7.2	7.5	8.0	6.0
-10	Pinnacle	Spreckels	18.5	2.7	3.0	5.2	6.8	6.8	7.2	5.3
-11	Alpine	Spreckels	19.7	2.8	3.2	4.8	6.3	6.5	6.7	5.1
-12	99HX928	Spreckels	20.8	2.8	3.5	4.7	5.8	6.5	6.3	4.9
-13	6CG7492	Betaseed	20.2	1.8	1.5	3.2	5.0	5.8	6.2	3.9
-14	US H11	Standard	21.0	3.7	4.8	7.0	7.8	7.5	7.7	6.4
-15	Beta 4210R	Betaseed	20.5	2.7	3.2	5.2	7.0	7.0	7.0	5.3
-16	98CX858	Spreckels	19.7	2.3	2.5	3.2	5.2	6.0	6.3	4.3
-17	7KJ0146	Betaseed	18.7	1.8	2.0	3.0	4.3	5.0	5.2	3.6
-18	H93203	Spreckels	20.3	2.7	3.2	4.8	6.2	6.7	6.5	5.0
-19	97CX14	Spreckels	18.5	2.2	2.8	4.5	5.7	6.3	6.5	4.7
-20	99HX912	Spreckels	20.2	2.5	3.0	4.2	5.3	5.7	6.5	4.5
-21	98CX861	Spreckels	20.8	2.2	2.5	3.7	5.2	5.7	6.2	4.2
-22	Imperial	Spreckels	19.2	2.3	2.7	4.7	6.0	6.5	6.3	4.8
-23	99HX915	Sprecekls	19.2	2.3	3.0	4.3	5.7	5.8	6.3	4.6
-24	Beta 4430R	Betaseed	20.5	1.5	2.0	3.3	4.8	5.5	6.0	3.9
-25	US H11	Standard	19.7	3.5	4.5	6.5	7.7	7.7	7.8	6.3

TEST 4200. CODED POWDERY MILDEW TEST, SALINAS, CA., 2000

(cont.)

Code No.	Variety	Company	Stand Count Mean	Powdery Mildew Score 08/17	08/21	08/28	09/05	09/11	09/18	Mean
PM-26	7CG7410	Betaseed	20.8	2.5	3.0	4.5	5.8	6.0	6.7	4.8
-27	98HX853	Spreckels	18.7	2.3	3.0	4.5	5.8	6.3	6.8	4.8
-28	US H11	Standard	20.2	3.2	4.2	5.8	7.2	7.5	7.7	5.9
-29	Phoenix	Spreckels	20.5	2.0	2.3	4.8	6.2	6.2	6.5	4.7
-30	99HX926	Spreckels	21.3	2.3	2.5	4.2	5.7	5.8	6.0	4.4
-31	7CG7376	Betaseed	20.2	1.0	1.0	1.2	2.3	3.0	3.3	2.0
-32	5KJ5061	Betaseed	19.7	2.2	3.0	5.3	6.7	6.5	6.7	5.1
-33	99HX917	Spreckels	19.5	3.3	4.0	6.3	7.2	7.0	7.2	5.8
-34	Rodeo	Spreckels	20.0	2.7	3.2	5.7	7.2	7.0	7.2	5.5
US H11	new (1999 seed)		19.0	3.7	4.5	6.3	7.8	7.5	7.5	6.2
R639	Inc. R539		19.3	1.0	1.3	3.3	4.3	4.8	5.3	3.4
8918-12	RZM-ER-% 6918-12		19.0	1.0	1.0	1.5	3.0	3.3	3.7	2.3
99-C37	Inc. U86-37		19.2	3.5	4.3	6.0	7.8	7.8	7.8	6.2
P913	PMR P813,CP01,WB97		18.0	2.3	2.3	3.7	5.0	5.2	5.7	4.0
P914	PMR P814,CP02,WB242		18.2	1.8	2.0	3.8	4.5	5.0	5.0	3.7
P915	C78 x P603,4		18.3	1.2	1.8	3.2	3.8	4.3	5.3	3.3
P907	C78 x (Y71 x P403,4)		18.5	1.2	1.3	2.5	4.0	4.7	4.8	3.1
P909	C78 x (C79-1 x P403,4)		19.3	1.2	1.8	3.3	4.3	4.5	5.2	3.4
P911	C79-1 x P403,4		18.0	1.8	1.8	3.3	4.7	4.5	5.2	3.6
P912	5915aa x P402NR		18.3	2.0	2.2	3.5	4.3	5.0	5.3	3.7
Rival	Spreckels		20.8	3.3	4.2	7.3	7.5	7.5	7.8	6.3
US H11	old		19.7	3.8	4.5	6.7	8.2	7.5	7.8	6.4
US H11	new (1999 seed)		18.8	3.8	5.2	6.7	8.0	7.8	8.0	6.6
Mean			19.5	2.4	2.9	4.6	5.9	6.1	6.4	4.7
LSD (.05)			1.7	1.0	1.1	1.2	1.0	0.8	0.7	0.7
C.V. (%)			7.8	34.3	34.3	22.4	14.5	11.5	9.7	12.7
F value			2.1**	5.3**	6.8**	11.1**	15.5**	16.1**	17.6**	20.4**

TEST 4200. CODED POWDERY MILDEW TEST, SALINAS, CA., 2000

(cont.)

Code No.	Variety	Company	Stand Count Mean	Powdery Mildew Score 08/17	08/21	08/28	09/05	09/11	09/18	Mean

NOTES: Powdery mildew was rated weekly from August 17 to September 18, 2000, on a scale of 0 to 9 where 9 = 90-100% of mature leaf area covered with visible mildew. Mean PM scores approximate the area under the disease progress curve, e.g., a rating of 5.0 would be about 50% of the leaf area covered during this period. Powdery mildew developed late from natural infection and there was a progressive decrease in severity from the top of the field (Rep 1) to the bottom (Rep 6) leading to significant replication effects.

USDA entries included an old and 1999 lot of US H11, R639 (C39R) line with intermediate reaction, 8918-12 line with moderate resistance, and P-numbered lines that segregate for high resistance (*Pm*) and high susceptibility (*pmpm*).

TEST 4600. EVALUATION OF BREEDING LINES TO *CERCOSPORA BETICOLA* AND RHIZOMANIA, SALINAS, CA., 2000

48 entries x 4 reps., sequential
1-row plots, 11 ft. long

Planted: April 12, 2000
Harvested: November 14, 2000
Inoc. *C.b.*: July 19 & 28; Aug. 14, 2000

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP	Cercospora Leaf Spot		
		Lbs	Tons	%	No.	%	11/01	11/13	Mean
Hybrids									
US H11	1999 production, 9-14-99	7398	26.81	13.80	157	89.4	6	6	6.1
Beta 4430R	L4430.8052	10956	32.45	17.05	175	88.0	7	8	7.3
Monodoro	Hill. CLSR (Italy), 3-25-99	11678	34.47	16.85	166	86.9	6	6	6.0
CR909-1H50	C790-15CMS x RZM R709-1	11986	35.28	16.77	182	83.2	7	7	6.9
Monohikari	4-16-99	8953	28.83	15.55	186	88.5	6	7	6.0
Rizor	Spreckels	14275	41.12	17.25	168	86.7	6	7	6.4
Dorotea	Hill. CLSR (Italy), 3-25-99	14151	40.31	17.50	184	86.5	5	6	5.6
Beta 4776R	Betaseed	13733	40.56	16.88	193	86.9	7	8	7.3
9931H50	C790-15CMS x RZM 8931	12564	38.10	16.55	170	85.5	6	6	5.9
9933H50	C790-15CMS x 8933	12537	37.49	16.73	173	86.7	6	7	6.3
CR911H50	C790-15CMS x CR811(C)	12819	38.10	16.77	155	87.2	6	7	6.1
CR911H35	8835aa x CR811(C)	12588	38.10	16.45	155	85.8	6	6	5.8
9933H6	8833-5H50 x 8933	12907	38.70	16.55	155	83.6	6	7	6.1
9931H5	8833-5aa x RZM 8931	14355	42.13	17.00	145	82.8	6	7	6.3
CR911H6	8833-5HO x CR811(C)	13030	39.31	16.65	145	85.9	5	6	5.6
Alpine	Spreckels	12604	37.29	16.83	177	85.4	6	7	6.4
Ippolita	Hill. CLSR (Italy), 3-25-99	11428	33.46	17.08	175	86.7	6	6	5.8
Phoenix	Spreckels	11768	34.87	16.88	175	87.9	7	7	6.8
MH-55	Lot 3M0217BCB, 1-30-98	7224	25.20	14.32	193	87.2	6	7	6.5
Beta 4419R	1-19-99	13737	41.12	16.65	182	86.8	6	7	6.4
ACH 205	Lot 0205C8602, 3-1-00	8090	26.00	15.60	177	86.9	6	7	6.3
MM,OP lines									
99-C37	Inc. U86-37	9422	30.24	15.55	161	88.1	6	7	6.4
99-C31/6	Inc. F86-31/6	8351	29.23	14.07	164	84.6	6	7	6.5
97-SP22-0	Inc. SP7622-0	5660	20.96	13.60	148	86.2	6	6	5.8

TEST 4600. EVALUATION OF BREEDING LINES TO *CERCOSPORA BETICOLA* AND RHIZOMANIA, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP	Cercospora Leaf Spot 11/01	Cercospora Leaf Spot 11/13	Cercospora Leaf Spot Mean
		Lbs	Tons	%	No.	%			
MM,OP lines (cont.)									
Y969(Iso)	RZM-ER-% Y769, (C69)	13244	38.30	17.30	168	85.2	6	7	6.0
99-EL-02/04	RZM 98-EL-02,-04	12972	40.72	15.92	164	87.2	6	6	5.9
99-FC123M	RZM-ER-% FC-1,-2,-3	8765	27.01	16.13	173	84.8	7	7	6.9
R978	RZM-ER-% R778	13363	37.84	17.63	145	85.4	5	6	5.5
R926	RZM R826, (C26)	13945	42.33	16.60	177	83.4	6	7	6.1
R927	RZM R827, (C27)	12420	37.29	16.65	175	84.3	6	7	6.3
Y975	RZM Y875	13563	41.02	16.45	175	85.2	5	7	5.9
951014	FC F_2 (mmaa x FC708), 4-12-9	7571	24.79	15.23	186	87.1	6	7	6.4
MM,S^f,Aa lines									
9931	RZM 8931aa x A	14253	42.13	16.88	170	86.4	6	7	6.0
9933	8933aa x A	12263	37.49	16.35	177	85.8	5	6	5.5
9941	941(C)aa x A	13289	39.51	16.80	159	85.6	5	6	5.5
Z831	RZM Z731,Z730,Z725(C)aa x A	12621	38.96	16.17	152	85.5	6	6	6.3
CR911(C)	CR811(C)aa x A	12696	38.20	16.60	143	85.7	5	6	5.5
7933	Inc. 6264-#(C)	9981	31.45	15.85	161	84.8	7	7	6.9
7932CT	Inc. 6260,…-#(A)	10384	32.45	16.08	161	85.2	6	7	6.4
9932	RZM 8932aa x A	12860	38.50	16.65	141	85.8	5	6	5.6
CR909-1	RZM R709-1	9826	29.03	16.98	157	82.7	6	8	6.9
R709-1	CR-RZM R509A-1	10243	30.44	16.83	173	80.9	7	8	7.3
CR910	RZM R710,RZM R709-9,…	12585	38.66	16.27	173	84.2	5	6	5.3
CR912	RZM-ER-% CR711,CR712	12380	36.49	16.98	175	84.3	6	6	6.0
CR811	RZM CR711 (CR09/10)	13432	39.91	16.80	177	85.0	6	6	5.8
CR812	RZM CR712	11575	35.07	16.55	168	82.8	6	6	5.8

TEST 4600. EVALUATION OF BREEDING LINES TO *CERCOSPORA BETICOLA* AND RHIZOMANIA, SALINAS, CA., 2000

(cont.)

Variety	Description	Acre Yield		Sucrose	Beets/ 100'	RJAP	Cercospora Leaf Spot		
		Sugar Lbs	Beets Tons	%	No.	%	11/01	11/13	Mean
monogerm, S^f, Aa lines									
9835	8835mmaa x A	12522	38.30	16.35	173	86.0	6	7	6.1
9869	RZM-ER-% 7869NB	10010	31.24	15.98	173	87.2	6	7	6.4
Mean		11645.4	35.36	16.35	167.9	85.7	5.8	6.5	6.2
LSD (.05)		3126.4	8.76	1.06	22.3	3.1	0.8	0.7	0.7
C.V. (%)		19.2	17.72	4.63	9.5	2.6	10.1	7.7	7.6
F value		3.8**	2.96**	5.52**	2.7**	2.4**	3.2**	4.1**	4.4**

CERCOSPORA: Ground leaf inoculum applied three times: July 19, July 28, and August 14, 2000. Each inoculation followed by frequent, brief sprinkler irrigations. Leaf spot scored on a scale of 0 to 9, where 9 = complete defoliation. Test was grown down wind from field corn buffers to reduce wind and lengthen dew periods. Disease development was late but moderate.

RHIZOMANIA: Soil was moderately infested with BNYVV.

Monodoro, Dorotea, and Ippolita obtained from Hilleshog Seed Co., in 1999. These are hybrids known to have double resistance to CLS and rhizomania in Italy.

TEST 4700. EVALUATION OF HALF-SIB PROGENY FAMILIES FOR REACTION TO *CERCOSPORA BETICOLA*, SALINAS, CA., 2000

12 checks x 4 reps., sequential
1-row plots, 11 ft. long

Planted: April 12, 2000
Harvested: November 15, 2000

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP	Cercospora Leaf Spot 11/01	Cercospora Leaf Spot 11/13	Cercospora Leaf Spot Mean
		Lbs	Tons	%	No.	%			
Checks									
Beta 4430R	L4430.8052, 3-10-99	10575	32.45	16.35	182	87.1	8	8	7.6
Monohikari	4-16-99	8038	27.41	14.70	175	87.3	6	7	6.1
97-SP22-0	Inc. SP7622-0	5317	18.54	14.23	161	86.8	5	6	5.4
CR911(C)	CR811(C)aa x A	9716	30.03	16.15	150	84.2	6	6	5.8
9933	8933aa x A	11022	34.27	16.08	168	84.8	6	6	5.8
9931	RZM 8931aa x A	10180	33.06	15.40	150	84.4	6	6	5.6
CR909-1	RZM R709-1	7353	23.79	15.52	168	78.7	6	7	6.6
CR910	RZM R710;R709-9,-10;…	9853	31.24	15.75	168	85.8	4	5	4.5
US H11	1999 production, 9-14-99	5763	24.19	11.93	159	87.7	6	7	6.3
CR811	RZM CR711, (CR09/10)	10158	32.63	15.57	148	83.9	5	6	5.4
CR812	RZM CR712	10332	32.25	16.00	166	86.0	6	6	6.0
CR912	RZM-ER-% CR711,712	10074	30.64	16.40	170	84.0	5	5	5.1
Mean		9031.8	29.21	15.34	163.8	85.1	5.6	6.1	5.8
LSD (.05)		1913.4	6.01	1.23	31.5	4.6	0.9	0.9	0.9
C.V. (%)		14.7	14.30	5.56	13.4	3.8	11.7	10.8	10.3
F value		8.5**	5.22**	8.68**	0.9NS	2.3*	6.6**	5.6**	6.9**

TEST 100. EVALUATION OF EXPERIMENTAL HYBRIDS FOR NONBOLTING, SALINAS, CA., 1999-2000

100 entries x 3 reps., sequential
1-row plots, 17.5 ft. long

Planted: November 11, 1999
Not harvested for yield

Variety	Description	Stand Count	Emergence Score	% Bolting				%Downey Mildew
		Mean	11/11	06/28	08/01	08/22	10/10	04/03
Checks								
US H11	9-14-99, new (resistant check)	27.7	1.0	0.0	2.4	3.6	3.6	0.0
SS-NB3	4-96, Spreckels (resistant check)	30.0	1.0	0.0	3.3	5.6	7.8	0.0
Beta 4776R	4776.9002 (9-8-99)	27.7	1.7	2.4	9.8	22.8	21.7	0.0
Beta 4430R	4430.9041 (9-8-99)	29.0	1.0	0.0	23.0	35.7	41.5	0.0
Rifle	Spreckels, 2-8-99	29.3	2.0	22.8	39.9	45.6	52.5	0.0
Rizor	2-8-99	27.3	1.0	12.2	39.1	50.0	61.0	0.0
Phoenix	1392401 (9-10-99)	30.3	1.7	8.8	18.8	23.2	31.4	0.0
Alpine	X612401 (9-10-99)	29.3	1.0	9.1	16.7	21.6	32.3	0.0
Monohikari	Seedex (4-16-99)	30.3	1.3	94.1	97.7	97.7	97.7	1.2
Y969H50 (Iso)	C790-15CMS x RZM-ER-% Y769	28.3	2.0	5.8	19.6	27.5	30.8	0.0
Hybrids with MM, O.P. Pollinators								
Y969H50 (Sp)	C790-15CMS x Y869 (C69)	28.3	1.0	7.2	16.4	16.4	17.5	0.0
R978H50	C790-15CMS x RZM-ER-% R778,% (C78)	27.7	1.7	15.0	16.4	17.4	18.5	1.4
R980H50	C790-15CMS x RZM-ER-% R780/2,(C80)	27.0	1.7	0.0	6.2	8.9	11.4	0.0
R970H50	C790-15CMS x RZM-ER R770	30.0	1.3	0.0	4.5	5.7	9.0	0.0
R976-89-18H50	C790-15CMS x R576-89-18, NB	26.3	1.7	8.8	12.4	14.9	14.9	0.0
R976-89-H50	C790-15CMS x R76-89-5/18	26.0	1.3	2.5	5.3	6.5	7.7	0.0
Y975H50	C790-15CMS x Y875	27.0	1.3	10.0	14.9	26.5	28.8	0.0
Y967H50	C790-15CMS x RZM-ER-% Y767 (C67)	27.3	1.3	6.4	21.3	27.5	33.8	0.0
Y971H50	C790-15CMS x RZM-ER-% Y771	29.3	2.0	10.1	16.6	23.4	23.4	1.1
R940H50	C790-15CMs x RZM-ER-% R740	30.3	1.0	8.2	27.8	33.6	35.9	0.0
R936H50	C790-15CMS x RZM-ER-% R736	31.3	1.3	13.7	21.1	23.2	24.1	0.0
R954H50	C790-15CMS x RZM-ER-% R754,R746	28.3	2.0	0.0	3.8	6.1	7.4	0.0
R943H50	C790-15CMS x RZM-ER-% R643	25.3	3.0	35.6	43.4	46.3	46.3	0.0

TEST 100. EVALUATION OF EXPERIMENTAL HYBRIDS FOR NONBOLTING, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count Mean	Emergence Score 11/11	% Bolting 06/28	% Bolting 08/01	% Bolting 08/22	% Bolting 10/10	%Downey Mildew 04/03
Hybrids with MM,S^f,Aa Pollinators								
9934H50	C790-15CMS x RZM 8934(C)	29.0	1.0	2.0	4.4	6.8	9.0	0.0
Z925H50	C790-15CMS x RZM-ER-% Z725(C)	23.3	2.7	7.2	18.1	29.6	35.2	0.0
P909H50	C790-15CMS x RZM-PMR P809,P810(C)	23.3	2.3	22.5	28.9	32.2	34.8	0.0
P911H50	C790-15CMS x RZM-PMR P811	25.3	2.0	32.5	40.4	47.4	49.7	0.0
P912H50	C790-15CMS x PM-RZM P812	24.0	2.3	1.2	1.2	2.4	5.7	1.2
CR909-1H50	C790-15CMS x RZM R709-1 (CR09-1)	24.3	2.3	16.0	19.9	27.0	28.4	0.0
9918-21H50	C790-15CMS x RZM 8918-21	27.3	1.0	0.0	1.1	2.4	6.1	0.0
9931H50	C790-15CMS x RZM 8931	27.3	1.7	3.8	8.5	13.4	13.4	0.0
9932H50	C790-15CMS x 8932	28.0	1.0	5.8	10.7	14.3	14.3	0.0
9933H50	C790-15CMS x 8933	25.3	1.0	10.3	11.7	15.4	18.0	0.0
CR911H50	C790-15CMS x CR811(C)	27.0	1.3	8.7	17.3	23.5	25.9	0.0
9941H50	C790-15CMS x 941(C)	27.0	1.3	1.2	7.3	14.8	16.1	2.4
9924H50	C790-15CMS x 8924	28.7	1.0	5.6	14.9	19.5	23.0	0.0
9926H50	C790-15CMS x 8926	27.0	1.0	0.0	7.6	13.9	13.9	1.3
9931-18H50	C790-15CMS x 7931-18	27.3	1.7	11.1	25.9	29.5	29.5	0.0
9931-24H50	C790-15CMS x 7931-24	27.7	2.0	2.4	4.8	4.8	4.8	0.0
9931-29H50	C790-15CMS x 7931-29	27.3	2.0	9.6	37.3	38.5	44.7	0.0
9924-2H50	C790-15CMS x 7924-2	30.3	1.0	1.1	4.3	6.5	7.7	0.0
9924-6H50	C790-15CMS x 7924-6	27.7	1.0	0.0	2.2	5.6	6.8	0.0
9924-10H50	C790-15CMS x 7924-10	28.3	1.0	9.4	26.8	31.6	33.8	0.0
9924-74H50	C790-15CMS x 7924-74%	29.0	2.3	6.3	8.6	11.0	13.0	0.0
9924-77H50	C790-15CMS x 7924-77	21.0	3.0	12.7	16.0	20.6	26.9	0.0
9924-78H50	C790-15CMS x 7924-78	24.7	2.3	0.0	2.8	2.8	5.7	0.0
9924-114H50	C790-15CMS x 7924-114VY	24.0	2.3	34.1	46.1	49.6	54.3	0.0

TEST 100. EVALUATION OF EXPERIMENTAL HYBRIDS FOR NONBOLTING, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count Mean	Emergence Score 11/11	% Bolting 06/28	% Bolting 08/01	% Bolting 08/22	% Bolting 10/10	%Downey Mildew 04/03
Hybrids with MM,S^f,Aa Pollinators (cont.)								
9929-4H50	C790-15CMS x 7924-4VY	20.7	3.3	3.8	7.1	8.8	10.4	2.1
9929-9H50	C790-15CMS x 7924-9VY	29.7	1.0	20.5	33.8	33.9	42.9	0.0
9929-45H50	C790-15CMS x 7924-45VY	28.3	1.0	6.9	14.2	14.2	14.2	1.1
9929-47H50	C790-15CMS x 7929-47VY	30.0	1.0	5.6	7.7	8.8	12.2	0.0
9929-48H50	C790-15CMS x 7929-48VY	29.0	1.7	0.0	0.0	0.0	0.0	0.0
9929-56H50	C790-15CMS x 7929-56VY	28.7	1.0	0.0	0.0	0.0	0.0	0.0
9929-62H50	C790-15CMS x 7929-62VY	30.7	1.0	1.2	1.2	1.2	1.2	0.0
9930-17H50	C790-15CMS x 7930-17VY	26.7	2.0	0.0	0.0	1.4	1.4	0.0
9930-32H50	C790-15CMS x 7930-32	27.0	1.7	10.1	33.5	40.2	44.8	1.2
9930-35H50	C790-15CMS x 7930-35	29.0	1.0	2.2	11.6	14.8	18.5	0.0
9927-4H50	C790-15CMS x 7927-4VY	27.0	2.0	1.1	5.1	9.0	14.3	0.0
9927-17H50	C790-15CMS x 7927-17VY	25.7	2.0	1.2	3.9	6.3	7.6	1.2
9928-34H50	C790-15CMS x 7928-34	25.7	2.0	3.9	6.4	7.6	13.9	0.0
9928-107H50	C790-15CMS x 7928-107	26.0	1.7	1.1	8.0	10.9	13.7	1.4
Experimental hybrids								
Y969H6	C833-5H50 x Y869	26.3	2.0	8.6	15.0	23.7	25.0	0.0
R976-89H6	C833-5H50 x R76-89-5/18	27.7	1.3	0.0	3.7	3.7	5.0	0.0
Y975H6	C833-5H50 x Y875	26.7	1.7	0.0	5.1	8.7	10.0	0.0
9931H6	C833-5H50 x RZM 8931	28.7	1.7	5.4	8.6	9.7	9.6	1.0
9941H6	C833-5H50 x 941(C)	29.0	2.0	2.0	7.2	8.2	10.3	0.0
9933H6	C833-5H50 x 8933	29.0	1.0	1.0	8.3	17.6	17.6	1.3
9926H6	C833-5H50 x 8926	30.3	1.0	10.1	19.7	27.4	32.6	0.0
Y969H5	C833-5aa x Y969	25.0	2.3	7.9	11.9	15.8	19.5	1.3
R976-89H5	C833-5aa x R576-89-5/18	30.3	1.0	2.2	4.4	6.6	9.9	0.0

TEST 100. EVALUATION OF EXPERIMENTAL HYBRIDS FOR NONBOLTING, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count Mean	Emergence Score 11/11	% Bolting 06/28	% Bolting 08/01	% Bolting 08/22	% Bolting 10/10	%Downey Mildew 04/03
Experimental hybrids (cont.)								
Y975H5	C833-5aa x Y875	27.3	2.3	7.0	10.7	11.8	11.8	1.1
9931H5	C833-5aa x RZM 8931	28.7	1.7	4.6	5.8	8.1	9.2	1.2
9941H5	C833-5aa x 941(C)	27.7	2.3	3.6	8.5	14.4	15.5	0.0
CR911H6	C833-5H50 x 8933	28.7	1.7	2.5	21.5	27.3	32.5	1.2
Y969H3	97-562HO x Y869	25.7	1.3	7.6	22.0	24.5	34.8	1.2
Y969H29	C829-3aa x Y869	20.3	2.3	9.6	13.1	14.6	16.3	0.0
Y969H4	C831-3aa x Y869	22.3	3.0	16.1	34.0	35.4	41.5	1.5
Y969H12	C833-12aa x Y869	21.3	3.0	36.4	64.3	65.9	67.5	0.0
Y969H45	C867-1HO x Y869	24.3	2.0	25.0	33.3	37.6	43.4	0.0
Y969H37	4807HO (C306/2) x Y869	25.0	1.7	17.4	35.0	36.4	36.4	0.0
Y969H46	7869-6HO x Y869	24.7	1.3	11.0	25.7	28.4	28.4	2.7
Y969H13	C833-12H50 x Y869	25.7	2.0	9.0	19.7	22.3	32.5	0.0
Y969H30	C829-3H50 x Y869	28.0	1.3	8.4	15.6	20.3	22.7	0.0
Y969H2	C831-3H50 x Y869	29.3	3.7	13.8	21.9	27.3	29.3	0.0
Y969H27	C831-4HO x Y869	25.3	1.3	16.2	27.3	33.9	35.2	2.7
Y969H33	C833aa x Y869	21.3	3.0	15.8	25.8	27.5	29.2	0.0
Y969H36	C8836aa x Y869	23.3	3.0	8.5	12.8	15.9	17.2	0.0
Y969H35	8835mmaa x Y869	28.7	1.0	12.9	22.7	30.1	31.1	0.0
Y969H38	8838mmaa x Y869	26.0	1.7	13.2	23.9	30.8	35.9	0.0
Y969H69	C869mmaa x Y869	24.3	3.7	11.1	22.0	28.8	34.3	1.4
Y969H87	C890mmaa x Y869	26.7	2.0	6.6	11.2	11.2	12.5	4.3
Y975H35	8835aa x Y875	26.0	1.7	10.3	23.5	29.0	38.5	0.0
9931H35	8835aa x RZM 8931	28.7	1.7	11.4	16.0	18.1	21.7	0.0
9932H35	8835aa x 8932	26.7	2.3	6.7	16.0	20.7	28.6	0.0
CR911H35	8835aa x CR811(C)	26.7	2.3	13.6	25.4	34.1	35.2	0.0

TEST 100. EVALUATION OF EXPERIMENTAL HYBRIDS FOR NONBOLTING, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count Mean	Emergence Score 11/11	% Bolting 06/28	% Bolting 08/01	% Bolting 08/22	% Bolting 10/10	%Downey Mildew 04/03
Experimental hybrids (cont.)								
9941H35	8835aa x 941(C)	29.3	1.7	3.0	6.6	9.1	11.1	0.0
9933H35	8835aa x 8933	29.7	1.0	14.7	25.9	31.5	37.0	1.2
9926H35	8835aa x 8926	28.3	1.0	4.6	17.7	24.8	29.4	0.0
US H11	old,	29.3	1.7	0.0	2.4	2.4	2.4	0.0
US H11	new, 9-14-99	30.3	1.0	2.2	3.3	3.3	4.3	0.0
Mean		27.2	1.7	8.9	16.8	20.6	23.4	0.4
LSD (.05)		4.7	1.4	8.9	11.6	13.5	15.0	2.2
C.V. (%)		10.8	50.8	61.7	42.9	40.6	39.7	363.4
F value		2.0**	1.8**	13.6**	12.4**	10.3**	9.4**	0.9NS

NOTES: The 1999-2000 winter/spring had very good induction temperatures for bolting. Bolting counts were made about monthly from late June to early October. Following counting, the seed stalks were trimmed and allowed to regrow. Counts for each date are accumulative.

Infection with downy mildew occurred naturally. On April 3, 2000, plants with visible DM were counted. During the season, rust and powdery mildew developed but were not scored.

Emergence was rated from 1 to 5 where 1 was best.

C833-5H50 = C790-15CMS x C833-5. HO = CMS.aa = genetic male sterility.

TEST 200. EVALUATION OF BREEDING LINES AND POPULATIONS FOR NONBOLTING, SALINAS, CA., 1999-2000

120 entries x 3 reps., sequential
1-row plots, 17.5 ft. long

Planted: November 11, 1999
Not harvested for yield

Variety	Description	Stand Count Mean	% Bolting 06/28	% Bolting 08/01	% Bolting 08/22	% Bolting 10/10	%Downey Mildew 04/03
Checks							
US H11	new, 9-14-99 (resistant check)	30.3	2.2	6.6	6.6	8.8	0.0
SS-NB3	Spreckels, 1996 (resistant check)	29.7	2.3	5.4	9.9	12.1	1.0
97-C37	Inc. U86-37, (C37) (resist. check)	27.7	1.1	3.6	3.6	5.0	1.3
97-SP22-0	Inc. SP7622-0 (susceptible check)	30.7	83.2	85.7	90.6	90.6	0.0
97-US22/3	Inc. Y009 (US22/3) (susc. check)	30.3	90.1	94.5	95.7	95.7	2.2
97-US75	Inc. 268 (US75)	28.3	4.0	9.7	11.7	13.7	0.0
B4776R	Betaseed	28.7	1.2	16.6	24.7	30.5	2.3
99-C46/2	Inc. U86-46/2	27.3	0.0	1.3	3.8	3.8	1.2
Multigerm, open-pollinated lines							
R778% (Iso)	RZM-ER R578 (C78)	29.0	21.0	23.5	24.5	27.0	2.4
R978	RZM-ER-% R778, % (C78)	28.3	16.9	22.9	23.9	25.1	3.2
R880	RZM R780 (C80)	28.7	10.6	18.7	21.0	25.6	0.0
R980	RZM-ER-% R780/2, … (C80)	28.0	1.3	6.2	7.5	7.5	0.0
R970	RZM-ER-% R770	27.3	2.1	4.4	6.5	6.5	2.7
99-C31/6	Inc. F86-31/6	28.3	8.1	14.7	15.8	18.1	1.2
R881 (Iso)	RZM R776, R781, R681 (C82)	32.7	17.5	26.6	29.7	31.7	3.2
Y869 (Iso)	RZM Y769, (C69)	29.3	13.6	20.5	23.9	25.1	1.1
Y969 (Sp)	RZM Y869	30.3	15.3	26.3	29.7	31.9	1.1
Y969 (Iso)	RZM-ER-% Y769, (C69)	31.7	26.0	34.9	45.4	49.5	1.0
R876-89-5NB	RZM-%S R576-89-5NB (C76-89-5)	31.3	3.3	5.4	9.7	9.4	0.0
R976-89-18	Inc. R576-89-18, NB (C76-89-18)	28.0	11.5	16.4	17.6	18.8	1.2
R976-89 (Sp)	R876-89-5rr x R576-89-18	29.0	3.4	13.1	15.6	15.6	0.0
99-FC-1,2,3M	RZM-ER-% FC-1,2,3	29.0	15.9	26.4	29.7	29.9	1.1
99-EL-02/04	RZM 98-EL-02/04	27.3	49.1	56.1	62.9	66.8	1.3
R943	RZM-ER-% R643	24.3	34.1	46.4	49.2	49.2	4.2

TEST 200. EVALUATION OF BREEDING LINES AND POPULATIONS FOR NONBOLTING, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count Mean	% Bolting 06/28	% Bolting 08/01	% Bolting 08/22	% Bolting 10/10	%Downey Mildew 04/03
Multigerm, open-pollinated lines (cont.)							
Y867	RZM Y767 (C67)	28.7	25.6	38.3	40.6	41.7	1.1
Y967	RZM-ER-% Y767 (Iso) (C67)	28.7	17.4	31.3	37.1	37.1	1.1
Y971	RZM-ER-% Y771	29.7	10.5	17.1	25.8	27.1	0.0
Y975	RZM Y875	28.0	11.8	22.1	23.4	23.4	0.0
R954	RZM-ER-% R754, R746	30.3	6.4	7.4	9.8	10.7	0.0
R940	RZM-ER-% R740	29.3	31.3	54.3	60.0	61.2	2.2
R936	RZM-ER-% R736 (C79-8)	29.7	23.8	47.1	54.8	58.4	0.0
R928	RZM R728 (C79-4)	30.0	1.0	1.0	2.2	1.0	1.1
R926	RZM R826, (C26)	28.3	34.4	40.2	45.3	53.8	13.8
R927	RZM R827, (C27)	29.7	15.9	37.3	40.6	44.0	0.0
P907	RZM-PMR P807,8(C)	28.7	8.4	13.0	29.0	30.0	1.3
P909	RZM-PMR P809,P810(C)	29.3	31.0	44.4	44.4	46.7	1.1
P911	RZM-PMR P811	30.3	35.1	45.9	48.2	48.2	4.5
P913	PMR P813, CP01 (WB97)	29.0	18.2	20.5	20.5	20.5	0.0
P914	PMR P814, CP02 (WB242)	27.3	32.8	36.2	39.8	39.8	0.0
P915	RZM-PMR P815,P816(C)	26.7	39.7	48.3	48.3	48.3	0.0
Multigerm, S^f,Aa populations & lines							
8931	RZM 7931aa x A (popn-931)	28.7	6.0	10.6	10.6	10.6	0.0
9931	RZM 8931aa x A (popn-931)	29.3	20.5	28.4	32.9	37.5	0.0
9924	RZM 8924aa x A (VY)	29.0	10.8	12.0	16.6	17.8	0.0
9932	RZM 8932aa x A (CT)	29.7	19.1	31.5	37.4	41.7	1.2
9933	8933aa x A (root aphid)	28.3	5.0	8.8	8.8	8.8	0.0
9941	941(C)aa x A (VY)	29.3	5.7	20.2	22.5	23.7	1.1
Z925	RZM-ER-% Z725(C) (%S)	27.7	27.4	41.0	47.4	47.4	4.8
9926	RZM 8926aa x A (*Bvm*)	28.0	10.3	20.4	26.7	26.7	1.0

TEST 200. EVALUATION OF BREEDING LINES AND POPULATIONS FOR NONBOLTING, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count Mean	% Bolting 06/28	% Bolting 08/01	% Bolting 08/22	% Bolting 10/10	%Downey Mildew 04/03
Multigerm, S^f,Aa populations & lines (cont.)							
9934	RZM 8934(C), (R76-89-5 x 7934)	29.0	4.9	8.2	11.9	14.4	0.0
P912	PM-RZM P812 (PM)	28.7	10.7	16.8	16.8	19.4	0.0
CR811	RZM CR711, (CR09,10)	27.0	30.9	43.0	44.3	45.5	0.0
CR812	RZM CR712	28.3	21.1	38.8	42.6	43.9	2.6
CR912	RZM-ER-% CR711,CR712	24.0	13.8	30.5	31.7	31.7	1.7
CR911(Sp)	CR811(C)aa x A (composite)	30.0	26.8	53.1	56.4	57.6	0.0
CR910	RZM R710,R709-9,R710-10,-14 (CR10)	29.3	21.1	42.9	48.6	53.3	0.0
CR909-1	RZM R709-1 (CR09-1)	29.0	13.0	27.8	38.9	41.2	3.9
N965M	RZM N865,6,7 (galls) (SBCNR)	28.7	1.1	6.9	10.5	12.8	0.0
N972	RZM N872,B(C),(WB-NR)	28.3	41.0	56.0	57.0	57.0	7.3
9719Bm	Inc. 6719, (C719Bm)	31.3	0.0	0.0	1.0	1.0	2.0
9918-21	RZM 8918-21	28.3	0.0	2.5	4.9	7.3	0.0
8911-4-10M	RZM-ER-% 6911-4-10 (C911-4-10)	26.0	0.0	0.0	0.0	0.0	0.0
8913-70	RZM-ER-% 6913-70 (C913-70)	31.3	1.1	2.1	2.1	2.1	5.4
8918-12	RZM-ER-% 6918-12	27.7	5.0	5.0	5.0	8.2	2.2
8929-153	Inc. 6929-153 (A,aa)	28.7	0.0	0.0	0.0	0.0	0.0
9928-107	Inc. 7928-107	26.3	5.2	19.7	24.4	26.5	2.7
9931-18	Inc. 7931-18	25.7	16.7	22.2	24.7	28.5	4.9
9931-24	Inc. 7931-24	24.0	0.0	0.0	0.0	0.0	0.0
9931-29	Inc. 7931-29	24.7	46.7	60.6	73.3	84.4	6.5
9924-2	Inc. 7924-2	24.7	1.3	5.4	9.7	9.7	21.1
9924-6	Inc. 7924-6	27.3	0.0	1.1	1.1	3.3	1.1
9924-10	Inc. 7924-10	23.3	19.6	48.1	59.2	63.8	1.4
9924-74	Inc. 7924-74%	24.3	3.9	6.6	6.6	7.9	0.0
9924-77	Inc. 7924-77	26.7	24.8	43.9	48.8	53.9	0.0
9924-78	Inc. 7924-78	25.7	0.0	2.4	2.4	3.6	0.0

TEST 200. EVALUATION OF BREEDING LINES AND POPULATIONS FOR NONBOLTING, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count Mean	% Bolting 06/28	% Bolting 08/01	% Bolting 08/22	% Bolting 10/10	%Downey Mildew 04/03
Multigerm, S^f,Aa populations & lines (cont.)							
9924-114	Inc. 7924-114VY	21.7	56.0	66.3	71.0	71.0	9.8
9929-4	Inc. 7929-4VY	25.0	1.4	1.4	4.3	4.3	0.0
9929-9	Inc. 7929-9VY	25.0	18.8	35.7	42.7	45.5	0.0
9929-45	Inc. 7929-45VY	25.7	14.1	14.1	14.1	14.1	6.8
9929-47	Inc. 7929-47VY	25.3	2.7	5.3	5.3	9.2	1.2
9929-48	Inc. 7929-48VY	26.3	0.0	0.0	0.0	0.0	1.2
9929-56	Inc. 7929-56VY	28.0	0.0	0.0	0.0	0.0	1.4
9929-62	Inc. 7929-62VY	28.0	0.0	0.0	0.0	0.0	3.6
9930-17	Inc. 7930-17VY	27.0	0.0	0.0	0.0	0.0	1.2
9930-32	Inc. 7930-32	24.3	10.2	24.7	31.6	34.2	1.5
9930-35	Inc. 7930-35	27.3	11.4	23.8	25.1	26.3	2.7
9927-4	Inc. 7927-4VY	27.0	2.3	6.1	8.6	11.1	1.3
9927-17	Inc. 7927-17VY	28.0	0.0	0.0	0.0	0.0	10.8
9928-34	Inc. 7928-34VY	30.3	1.1	7.9	7.9	9.1	2.2
Monogerm, S^f,Aa Populations and Lines							
9833	RZM 8833	30.3	5.5	17.6	19.8	20.9	1.1
9835(T-O)	RZM,T-O 8835-#(C)	31.0	7.5	17.2	24.9	30.1	0.0
9835	RZM 8835mmaa x A	30.7	1.1	9.7	13.0	15.2	1.1
9835HO	8835HOmm x 8835	31.0	3.5	7.5	8.7	15.5	0.0
9836	RZM 8836	31.3	1.1	2.2	2.2	4.4	0.0
9838	RZM 8838mmaa x A	28.7	0.0	12.0	12.0	14.3	0.0
9838HO	RZM 8838Homm x A	29.3	3.2	9.9	15.6	15.6	1.1
9869	RZM-ER-% 7869NB (C869)	31.0	1.0	2.0	5.1	6.3	0.0
9840	840(C)mmaa x 840(C2)A	27.7	3.3	4.4	6.6	7.9	1.0
9840HO(A)	8835HO x 840(C2)A	27.7	11.5	22.2	29.2	32.2	0.0
9818M	RZM-ER-% 7818/2,...	26.7	11.8	16.2	19.5	26.3	1.6
9808	RZM,T-O 8808-#-#(C)	25.0	1.2	12.8	12.8	16.3	0.0

TEST 200. EVALUATION OF BREEDING LINES AND POPULATIONS FOR NONBOLTING, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count Mean	% Bolting 06/28	08/01	08/22	10/10	%Downey Mildew 04/03
Monogerm, S^f,Aa Populations and Lines(cont.)							
99-790-15	Inc. F92-790-15 (C790-15)	28.7	0.0	7.5	9.5	9.5	0.0
99-790-15CMS	U88-790-68CMS x F92-790-15	16.3	16.3	20.7	31.4	43.9	0.0
99-790-68	Inc. U88-790-68 (C790-68)	23.7	0.0	1.4	7.4	7.4	0.0
99-790-68CMS	U88-790-68CMS x U88-790-68	23.7	1.5	3.0	5.8	9.9	1.5
C833-5(T-O)	RZM,T-O 8833-5-#(C)	25.3	0.0	0.0	0.0	4.3	0.0
C833-5(T-O)HO	RZM 8833-5H50 x RZM,T-O 8833-5-#(C)	25.7	0.0	4.3	5.6	7.9	0.0
C833-5	RZM 8833-5	24.7	1.4	4.3	8.3	8.3	1.4
C833-5HO	RZM 8833-5HO x RZM 8833-5	25.7	1.2	1.2	4.0	5.2	1.2
C833-12	RZM 8833-12	24.0	25.4	41.6	50.5	49.2	3.5
C831-3	RZM 8831-3	23.0	0.0	2.4	2.4	2.4	0.0
C831-4	RZM 8831-4	24.3	0.0	0.0	0.0	0.0	0.0
C867-1	RZM 7867-1m	23.3	10.1	12.7	19.0	22.2	1.3
C829-3	RZM 8829-3(C)	26.3	0.0	0.0	0.0	1.2	2.6
9869-6	RZM 7869-6	27.3	5.3	12.2	13.7	13.7	0.0
8936	RZM R776-85-5H31	28.0	2.4	5.8	6.9	10.6	0.0
99-C37	Inc. U86-37, (C37)	27.0	1.1	3.4	5.6	5.6	0.0
C762-17	Inc. 0762-17,2762-17	25.7	2.7	5.2	5.2	8.0	1.2
C718	Inc. U83-718	28.0	2.4	2.4	3.6	4.8	1.2
C562	Inc. F82-562	27.7	2.3	5.8	9.4	9.4	2.5
C546	Inc. F82-546	31.3	1.0	3.1	3.1	4.0	0.0
Mean		27.7	11.9	18.9	21.9	23.7	1.6
LSD (.05)		4.8	11.4	12.5	13.6	14.2	5.7
C.V. (%)		10.7	59.6	41.3	38.7	37.3	217.4
F value		2.1**	14.6**	18.1**	17.8**	17.3**	2.0**

Note: See Test 100.

TEST 1200. BORDERS AND SELECTION FOR NONBOLTING TENDENCY
SALINAS, CA., 1999-2000

8 entries x 1-row 528 ft. long
1-row plots, 52 ft. long

Planted: November 11, 1999
Not harvested for yield

Variety	Description	Stand Count 2/10/00	% Downey Mildew 4/3/00	% Bolting 6/28	% Bolting 8/01	% Bolting 8/22	% Bolting 10/10
MM,S^f,Aa,*Rz* popns							
9932	RZM 8932aa x A	801	0.5	9.4	23.2	29.0	30.0
CR911(Sp)	CR811(C)aa x A (Comp)	892	0.4	25.3	36.3	41.1	39.5
9941	941(C)aa x A	910	2.0	5.4	10.4	12.3	13.4
9926	8926aa x A	843	7.5	10.8	18.3	18.5	20.2
9931	RZM 8931aa x A	942	7.5	6.2	14.1	15.8	19.4
9933	8933aa x A	910	1.8	3.6	7.1	7.6	8.6
mm,S^f,Aa,*Rz* popns							
9840	840(C1)aa x 840(C2)A	842	1.0	3.6	8.4	11.8	12.6
9835	8835mmaa x A	915	2.3	3.3	11.4	15.2	17.2
Check							
Beta 4776R	Outside border on S	1005	1.1	1.0	9.1	14.7	13.6
Beta 4776R	Outside border on N	1025	1.8	1.5	15.3	25.1	34.3

Winter of 1999-2000 was excellent for induction of bolting.
Following each count, bolters were trimmed to top of canopy.
Counts for each date were accumulative.

NOTE: Bolting response to localized conditions: Beta 4776R on the outside border on the south had less than 50% of the bolting of that on the North outside border. This is probably due to temperature and shading effects. The southern border would be directly exposed to the sun, particularly in the winter and the northern one would have been partially shaded by the adjacent rows on its south. It has been repeatedly observed that bolting is influenced by many environmental factors including shading, orientation and direction of the beds, disease, nitrogen, fertility, etc.

TEST 1100. EVALUATION OF TOPCROSSES FOR NONBOLTING, SALINAS, CA., 1999-2000

128 entries x 3 reps., sequential
1-row plots, 11 ft. long

Planted: November 11, 1999
Not harvested for yield

Variety	Description	Stand Count No.	DM Infection %	Emergence Score 12/21	% Bolting 06/28	% Bolting 08/01	% Bolting 08/22	% Bolting 10/10	Rhizoctonia No.	Rhizoctonia %
Checks										
SS-NB3	Spreckels, 1996	17.3	6.1	1.0	0.0	5.5	10.7	10.7	0.0	0.0
US H11	old	17.7	0.0	2.0	2.1	5.8	5.8	5.8	0.0	0.0
US H11	new, 9-14-99	15.7	0.0	1.0	0.0	3.3	0.0	1.6	0.0	0.0
B4776R	4776.9002 (9-8-99)	18.3	0.0	1.3	1.9	19.8	30.7	43.0	0.0	0.0
Topcrosses to C833-5-#s										
Y969H50	C790-15CMS x Y869	18.7	1.6	1.3	5.4	19.4	24.7	24.7	0.3	1.6
Y969H5	8833 -5aa x Y869	16.7	1.9	2.0	7.1	16.4	20.6	24.9	1.0	5.6
Y939H6	8833 -5H50 x Y869	17.7	1.9	1.3	7.4	18.7	18.7	18.7	0.7	3.7
Y969H5 -52	8833 -5-2mmaa x Y869	15.0	0.0	2.3	2.0	2.0	6.0	8.8	0.7	4.9
Y969H5 -53	-5-3	15.7	3.9	2.0	13.9	22.5	27.7	30.2	1.3	8.4
-56	-5-6	14.7	0.0	2.7	0.0	7.2	7.2	7.2	1.0	7.0
-57	-5-7	16.3	6.1	2.3	10.4	16.4	18.5	20.5	1.3	8.1
-58	-5-8	13.0	2.8	2.3	15.3	20.6	27.9	27.9	0.7	5.3
-59	-5-9	16.3	0.0	2.3	2.2	16.5	18.6	20.5	0.0	0.0
-510	-5-10	15.7	2.0	1.3	10.6	16.7	25.1	38.4	0.7	4.2
-511	-5-11	14.7	0.0	2.3	7.0	18.3	20.4	23.0	0.0	0.0
-512	-5-12	18.0	3.7	1.7	0.0	9.3	11.1	11.1	2.3	13.0
-513	-5-13	14.3	2.8	1.7	2.6	20.4	30.6	32.5	1.0	6.5
-515	-5-15	17.0	0.0	1.7	3.9	12.0	19.6	21.4	1.3	7.8
-517	-5-17	14.7	9.2	2.0	6.5	13.4	13.4	17.9	1.7	11.3
-518	-5-18	13.7	2.8	2.0	0.0	5.2	7.4	7.4	0.3	2.8
-519	-5-19	15.0	7.1	2.0	0.0	2.2	8.7	8.7	2.0	13.5
-521	-5-21	16.0	2.1	1.7	2.2	12.4	12.4	12.4	1.0	6.1

TEST 1100. EVALUATION OF TOPCROSSES FOR NONBOLTING, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count No.	DM Infection %	Emergence Score 12/21	% Bolting 06/28	% Bolting 08/01	% Bolting 08/22	% Bolting 10/10	Rhizoctonia No.	Rhizoctonia %
Topcrosses to C833-12-#s										
Y969H12	8833 -12aa x Y869	15.0	2.2	2.7	30.8	57.2	64.3	66.6	0.3	2.1
Y969H13	8833-12H50 x Y869	14.7	0.0	2.0	13.7	24.8	29.2	33.5	0.7	4.3
Y969H12 -122	8833 -12-2mmaa x Y869	16.7	4.2	2.0	18.1	34.5	36.6	38.4	1.0	6.0
-124	-12-4mmaa x Y869	16.3	2.2	2.3	30.5	50.3	54.2	54.2	0.3	2.2
-127	-12-7mmaa x Y869	15.7	4.4	2.7	42.4	49.0	59.9	59.9	0.7	4.2
Topcrosses to C829-3-#s										
Y969H29	8829 -3aa x Y869	15.7	0.0	1.7	16.9	24.7	28.7	33.2	1.3	7.8
Y969H30	8829 -3H50 x Y869	53.0	0.0	1.0	1.7	7.0	10.5	10.8	0.3	1.8
Y939H29 -31	8829 -3-1mmaa x Y869	16.3	1.9	3.0	8.6	30.4	37.1	40.9	0.7	4.2
-35	-3-5mmaa x Y869	15.7	0.0	2.3	4.2	14.7	21.0	23.1	0.3	2.1
-39	-3-9mmaa x Y869	17.3	0.0	2.7	1.9	9.4	17.9	19.7	0.0	0.0
-310	-3-10mmaa x Y869	17.0	1.9	2.0	3.8	17.6	21.7	23.8	0.7	3.9
Topcrosses to popn-835-#s										
Y969H35	8835mmaa x Y869	15.3	3.9	1.7	11.3	26.3	32.7	37.4	2.0	13.1
Y969H55	8835HO x Y869	17.0	0.0	1.7	5.9	10.4	15.9	18.1	0.7	3.7
Y969H35 - 1	8835 - 1mmaa x Y869	14.3	0.0	1.3	4.4	8.6	10.7	10.7	1.0	7.2
Y969H35 - 2	8835 - 2mmaa x Y869	13.7	9.9	2.0	7.3	9.9	17.0	19.4	1.7	12.3
- 3	- 3	15.3	2.1	3.0	15.3	24.0	37.2	37.2	0.3	2.1
- 4	- 4	16.0	1.7	2.3	14.2	34.4	41.2	41.2	0.3	2.6
- 6	- 6	15.7	2.1	1.3	14.7	23.2	29.9	34.3	1.0	6.3
- 7	- 7	14.7	2.8	1.0	2.2	12.0	14.2	18.4	2.0	13.9
- 8	- 8	15.0	2.2	2.7	8.7	17.8	24.2	36.0	1.0	6.4
- 9	- 9	16.0	0.0	2.7	8.3	18.9	23.1	25.3	0.0	0.0
-10	-10	15.3	0.0	2.7	4.5	13.4	17.9	20.2	1.0	6.8

TEST 1100. EVALUATION OF TOPCROSSES FOR NONBOLTING, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count	DM Infection	Emergence Score	% Bolting				Rhizoctonia	
		No.	%	12/21	06/28	08/01	08/22	10/10	No.	%
Topcrosses to popn-835-#s (cont.)										
Y969H35 -11	8835 -11mmaa x Y869	15.3	0.0	2.3	12.9	26.1	26.1	34.7	0.3	2.1
-12	-12	10.7	3.3	3.3	8.9	24.0	24.0	24.0	0.7	6.7
-13	-13	15.7	2.0	1.7	48.4	65.8	73.6	73.6	0.7	5.0
-14	-14	12.3	0.0	2.7	11.5	23.0	26.0	31.4	0.3	3.0
-16	-16	16.7	0.0	1.3	10.1	18.2	24.5	24.5	0.3	2.2
-17	-17	17.3	5.6	2.7	3.7	7.6	11.3	11.3	1.0	5.8
-18	-18	16.0	1.9	1.7	15.5	42.4	44.2	46.6	1.7	10.0
-22	-22	18.0	1.6	1.7	0.0	3.7	7.3	7.3	2.0	10.8
-24	-24	17.0	0.0	1.3	15.7	19.6	25.5	35.3	1.0	5.9
-25	-25	19.0	1.8	1.3	10.2	13.7	17.2	17.2	0.3	1.8
-26	-26	15.7	0.0	3.0	31.8	52.9	55.3	57.7	0.7	4.3
-28	-28	17.0	2.1	2.3	13.9	25.7	29.8	31.8	0.7	4.2
-31	-31	16.3	10.5	2.0	0.0	7.7	9.6	9.6	4.0	23.9
-32	-32	15.3	6.8	2.0	9.2	17.7	21.7	23.6	1.7	10.5
-33	-33	14.7	0.0	1.7	29.4	47.1	51.5	54.0	0.0	0.0
-33B	-33B	15.7	2.1	1.7	38.4	59.5	66.6	68.7	0.3	2.1
-35	-35	14.0	4.2	2.0	0.0	2.1	2.1	9.6	0.7	4.9
-41	-41	17.3	2.0	1.7	22.9	30.5	45.9	45.9	1.3	7.7
-42	-42	16.0	12.5	1.7	12.7	31.7	37.6	43.7	1.3	8.3
-43	-43	15.3	0.0	3.0	6.6	13.2	23.5	25.9	1.0	7.1
-45	-45	16.3	3.9	1.0	8.5	22.5	24.8	26.9	0.3	1.9
-47	-47	14.7	2.2	2.0	6.7	13.7	16.0	22.7	1.3	9.0
-48	-48	16.0	10.7	1.3	6.3	10.2	12.4	12.4	1.7	10.2
-51	-51	16.0	7.1	1.3	5.9	22.4	26.8	28.7	0.7	4.3

TEST 1100. EVALUATION OF TOPCROSSES FOR NONBOLTING, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count	DM Infection	Emergence Score	% Bolting				Rhizoctonia	
		No.	%	12/21	06/28	08/01	08/22	10/10	No.	%
Topcrosses to popn-835-#s (cont.)										
Y969H35 -53	8835 -53mmaa x Y869	15.3	4.5	2.0	8.3	14.9	19.6	24.1	1.0	6.5
-54	-54	16.3	2.1	1.0	32.8	46.8	51.0	53.1	1.3	8.2
-61	-61	13.0	11.3	3.0	2.2	7.0	7.0	9.2	1.3	9.2
-62	-62	14.7	10.3	2.7	7.8	16.4	20.6	23.4	3.0	21.7
Topcrosses to popn-835-#s										
Y969H35 -74	8835 -74mmaa x Y869	16.7	3.6	2.3	6.8	24.8	24.8	29.9	0.3	2.6
-75	-75	15.7	4.4	2.3	8.5	16.9	19.2	27.5	2.0	12.8
-78	-78	16.7	6.4	1.0	14.3	24.1	24.1	27.8	1.3	7.9
-79	-79	17.0	9.5	2.7	26.0	38.0	49.9	53.9	1.0	5.6
-80	-80	16.3	4.2	2.0	26.0	44.7	48.9	53.3	0.3	2.0
-81	-81	17.0	1.8	2.3	10.4	28.5	32.0	35.9	1.0	5.5
-82	-82	15.3	6.5	2.3	13.2	28.3	34.9	37.1	1.7	10.7
-85	-85	16.3	6.1	2.0	10.0	18.3	20.3	22.4	2.0	12.3
Y969H35 -87	8835 -87mmaa x Y869	16.7	8.3	1.3	20.1	32.2	34.0	34.0	0.7	3.9
Y969H35	8835mmaa x Y869	16.0	7.0	1.7	16.5	25.7	25.7	29.9	2.0	13.2
Y969H50	C790-15CMS x Y869	15.3	3.9	1.7	11.3	24.3	31.1	31.1	1.7	10.2
Y969H3	97-562HO x Y869	16.7	4.2	1.3	0.0	13.5	19.5	23.7	1.3	8.4
Topcrosses to lines-808-#-#s										
Y969H10	8810mmaa x Y869	16.7	8.1	1.7	3.9	16.0	19.9	31.7	1.0	6.0
Y969H48	8848mmaa x Y869	17.0	3.9	2.0	11.8	19.7	25.4	29.5	1.0	6.0
Y969H87	8890mmaa x Y869	17.3	5.5	1.7	5.9	9.4	9.4	9.4	1.7	9.7
Y969H49	8848HO x Y869	17.0	5.8	1.7	8.0	17.7	21.7	23.6	1.3	7.9
Y969H17	7817HO x Y869	17.3	0.0	1.0	13.0	24.1	25.9	29.6	0.7	3.7
Y969H18	7818HO x Y869	17.0	5.9	1.7	14.8	27.0	28.9	33.0	1.3	7.4
Y969H18-1B	8818-1BHO x Y869	18.0	3.7	1.7	1.9	9.3	13.0	16.7	1.0	5.6
Y969H18-2B	8818-2BHO x Y869	17.0	0.0	1.7	9.9	23.4	27.2	29.2	0.7	3.9

TEST 1100. EVALUATION OF TOPCROSSES FOR NONBOLTING, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count	DM Infection	Emergence Score	% Bolting				Rhizoctonia	
		No.	%	12/21	06/28	08/01	08/22	10/10	No.	%
Topcrosses to lines-808-#-#s (cont.)										
Y969H9 -24	8808 -2-4mmaa x Y869	15.7	4.2	1.3	26.5	48.0	58.4	64.3	1.0	6.4
-25	-2-5	15.7	0.0	1.3	32.6	40.7	57.6	57.6	1.0	6.5
-26	-2-6	16.0	8.6	2.0	4.0	12.1	20.2	23.7	2.0	12.2
-31	-3-1	14.0	6.8	2.0	4.9	9.9	16.9	24.2	1.7	11.3
-32	-3-2	15.7	6.4	2.0	2.0	10.3	12.7	14.8	0.7	4.0
-33	-3-3	15.0	0.0	2.3	17.5	30.6	37.6	44.1	1.0	6.7
-35	-3-5	16.7	0.0	2.3	4.0	8.0	14.1	21.9	0.7	3.9
-36	-3-6	17.7	3.8	2.3	5.6	13.1	20.5	26.1	1.0	5.8
-41	-4-1	17.3	0.0	1.3	6.0	13.2	19.1	20.9	0.7	3.9
-42	-4-2	17.3	3.8	2.0	1.9	11.2	15.1	18.8	1.7	9.8
-45	-4-5	17.0	2.0	2.7	7.8	13.7	25.5	27.5	1.7	9.8
-46	-4-6	14.7	0.0	3.0	0.0	0.0	2.0	2.0	0.0	0.0
-47	-4-7	16.0	0.0	2.0	0.0	4.8	4.8	7.1	0.7	4.3
-72	-7-2	16.0	0.0	1.7	0.0	0.0	2.1	6.3	0.0	0.0
-74	-7-4	15.7	10.1	2.0	4.2	8.6	8.6	13.1	1.7	10.1
-85	-8-5	13.0	16.7	2.3	6.7	6.7	10.0	12.1	2.7	20.9
-92	-9-2	14.7	0.0	2.7	11.3	22.5	22.5	24.8	0.0	0.0
-93	-9-3	16.7	6.3	1.7	4.1	8.5	10.4	10.4	2.7	16.5
-94	-9-4	16.3	6.3	1.3	8.0	14.1	20.3	22.3	0.7	4.2
Y969H9 -96	8808 -9-6mmaa x Y869	16.0	5.9	1.7	2.1	14.4	25.2	27.3	1.3	8.3
Topcrosses to lines-808-#-#s										
Y969H9 - 97	8808 - 9-7mmaa x Y869	16.0	6.3	2.3	6.3	10.4	16.7	18.5	1.3	7.8
-913	- 9-13	15.7	0.0	2.3	7.6	25.0	28.9	30.6	1.3	10.1
-121	-12- 1	13.7	2.6	1.7	4.8	22.7	25.3	35.6	1.0	7.0
-123	-12- 3	11.3	8.3	2.7	5.2	27.6	32.3	32.3	1.3	13.9

TEST 1100. EVALUATION OF TOPCROSSES FOR NONBOLTING, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count	DM Infection	Emergence Score	% Bolting				Rhizoctonia	
		No.	%	12/21	06/28	08/01	08/22	10/10	No.	%
Topcrosses to lines-808-#-#s (cont.)										
Y969H9 -124	8808 -12- 4mmaa x Y869	15.7	4.2	2.0	13.3	24.2	37.6	45.0	0.7	4.2
-125	-12- 5	16.0	6.3	2.3	6.3	17.0	19.2	21.4	2.7	16.7
-126	-12- 6	17.0	2.2	2.3	8.2	26.7	33.1	38.1	0.7	3.9
-131	-13- 1	11.3	8.3	2.7	16.7	19.0	29.8	32.1	1.3	14.6
-132	-13- 2	17.0	4.0	2.0	6.4	18.5	26.4	26.4	1.0	5.9
-162	-16- 2	14.7	4.3	2.3	2.1	4.2	11.2	20.1	1.7	10.6
-166	-16- 6	15.3	0.0	3.0	6.6	12.6	19.2	21.1	0.3	2.6
-167	-16- 7	13.3	8.3	3.0	5.2	17.5	27.0	27.0	1.3	10.3
SS-NB3	Spreckels	18.0	0.0	1.7	3.6	5.4	7.3	12.8	0.0	0.0
B4776R	4776.9002 (9-8-99)	18.3	1.7	1.0	1.9	16.5	31.1	34.6	0.0	0.0
US H11	new, 9-14-99	19.3	0.0	1.0	1.8	5.2	5.2	5.2	0.0	0.0
Y969H3	97-562HO x Y869	16.3	0.0	2.0	3.7	16.4	24.4	30.4	0.3	2.1
Mean		16.2	3.4	2.0	9.6	19.6	24.4	27.4	1.0	6.4
LSD (.05)		8.8	8.8	0.9	12.6	15.7	17.9	18.4	1.5	9.5
C.V. (%)		33.8	158.8	27.8	81.3	49.8	45.6	41.8	92.0	92.4
F value		1.3*	1.2NS	3.1**	4.2**	5.2**	5.0**	4.9**	1.8**	1.9**

TEST 900. EVALUATION OF MULTIGERM S_n PROGENY LINES FROM CR LINES & SOURCES, SALINAS, CA., 1999-2000

32 entries x 3 reps., sequential
1-row plots, 11 ft. long

Planted: November 11, 1999
Not harvested for yield

Variety	Description	Stand Count No.	Downey Mildew Count	DM Infection %	Emergence Score 12/21	% Bolting 06/28	% Bolting 08/01	% Bolting 08/22
CR910-# = R7100⊗; = CR-RZM R509,10-#(C)								
CR910 - 1	R710⊗	12.0	3.7	31.4	3.0	44.6	39.3	44.6
- 2		13.7	0.0	0.0	3.0	7.7	9.9	12.5
- 3		14.7	2.3	15.4	3.0	21.4	32.7	39.4
- 4		13.3	0.7	4.4	2.7	10.0	35.9	38.3
CR911-# = RZM CR811⊗; = RZM CR711 (CR09/10)								
CR911 - 1	RZM CR811⊗	11.7	0.7	6.7	3.0	31.3	51.6	57.0
- 2		13.7	0.3	2.0	3.0	0.0	5.1	5.1
- 3		13.7	0.0	0.0	2.3	22.2	29.3	42.1
- 4		14.0	0.3	2.6	3.0	0.0	2.2	2.6
CR912-# = RZM CR812⊗; = RZM CR712; = 931aa x CR11(C)								
CR912 - 1	RZM CR812⊗	15.0	0.0	0.0	2.3	6.7	20.0	35.6
- 2		10.3	0.3	3.0	3.0	23.0	32.7	35.8
- 3		14.0	0.3	2.0	2.3	10.7	14.6	22.5
- 4		13.7	0.0	0.0	2.7	4.8	6.8	16.4
- 5		13.0	0.7	5.1	3.0	7.7	17.6	28.3
- 6		15.3	0.3	2.6	2.7	2.1	36.5	58.9
CR913-# = RZM CR813⊗; = RZM CR713; = CTRaa x CR11(C)								
CR913 - 1	RZM CR813⊗	12.7	1.7	12.6	3.0	70.1	70.5	85.6
- 2		12.0	0.3	2.8	3.0	66.5	57.9	68.6
- 3		14.3	3.3	23.2	3.0	11.4	13.7	23.2
- 4		15.3	0.3	1.9	3.0	43.1	56.3	67.2

TEST 900. EVALUATION OF MULTIGERM S_n PROGENY LINES FROM CR LINES & SOURCES, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count	Downey Mildew	DM Infection	Emergence Score	% Bolting		
		No.	Count	%	12/21	06/28	08/01	08/22
CR913-# = RZM CR813⊗; = RZM CR713; = CTRaa x CR11(C) (cont.)								
CR913- 5	RZM CR813⊗	15.7	1.3	8.6	2.0	2.1	6.3	8.3
- 6		11.7	0.3	2.2	3.3	33.6	49.2	62.6
- 7		12.3	0.0	0.0	3.3	8.3	12.7	12.7
- 8		11.7	0.7	5.8	3.0	37.9	64.0	81.9
CR909-1-# = R709-1⊗; = CR-*Rzm* R509A-1; = R409A⊗								
CR909- 1-1	R709-1⊗	13.0	0.3	2.8	3.0	45.8	74.0	77.0
- 1-2		13.3	0.3	2.6	3.0	17.7	57.8	62.4
- 1-3		11.7	2.0	17.8	3.0	44.8	56.8	54.5
- 1-4		14.7	0.7	4.6	3.0	27.0	59.5	71.0
CR909-9-# = RZM R709-9⊗; = CR-RZM R509A-9; = R409A⊗								
CR909- 9-1	RZM R709-9⊗	14.0	2.7	21.4	3.0	0.0	6.5	15.5
- 9-2		11.7	0.7	5.6	3.0	0.0	5.6	8.2
CR910-10-# = RZM R710-10⊗; = CR-RZM R510A-10; = R410A⊗								
CR910-10-1		14.3	2.7	18.6	3.0	2.4	2.4	2.4
-10-2		12.7	1.0	8.3	3.0	0.0	0.0	0.0
CR910-14-# = RZM R710-14⊗; = CR-RZM R510A-14; = R410A⊗								
CR910-14-1	RZM R710-14⊗	13.3	0.0	0.0	3.0	0.0	2.2	0.0
-14-2		14.0	0.0	0.0	3.0	0.0	0.0	0.0
Mean		13.3	0.9	6.7	2.9	18.8	29.1	35.6
LSD (.05)		2.9	1.8	15.0	0.6	16.9	20.5	23.3
C.V. (%)		13.5	128.2	137.1	13.0	55.1	43.2	40.1
F value		1.6NS	2.5**	2.3**	1.7*	11.3**	11.0**	11.0**

TEST 1000. EVALUATION OF MONOGERM, S1 PROGENY LINES FROM RANDOM-MATED POPULATIONS FOR NONBOLTING, SALINAS, CA., 1999-2000

96 entries x 3 reps., sequential
1-row plots, 11 ft. long

Planted: November 11, 1999
Not harvested for yield

Variety	Description	Stand Count	Downey Mildew	DM Infection	Emergence Score	% Bolting			Rhizoctonia	
		No.	Count	%	12/21	06/28	08/01	08/22	No.	%
Checks										
9840	840(C1)mmaa x 840(C2)	16.3	0.0	0.0	1.0	4.2	8.6	12.5	0.0	0.0
9835(Sp)	RZM 8835mmaa x A	16.7	0.0	0.0	1.3	0.0	11.9	11.9	0.0	0.0
9835(T-O)	RZM, T-O 8835-#(C)	16.0	0.0	0.0	2.0	8.9	26.3	35.0	0.0	0.0
9869	RZM-ER-% 7869NB, …	15.7	0.0	0.0	1.7	0.0	2.2	4.4	0.0	0.0
9833-5	RZM 8833-5 (C833-5)	15.3	0.3	2.0	2.3	0.0	10.2	12.7	0.0	0.0
9831-3	RZM 8831-3 (C831-3)	17.0	0.3	1.8	1.0	0.0	0.0	0.0	0.3	1.8
9831-4	RZM 8831-4 (C831-4)	18.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
9869-6	RZM 7869-6	19.3	3.7	20.4	1.0	3.7	7.0	10.4	0.0	0.0
9833-# = RZM 8833mm⊗										
9833 - 1	RZM 8833mm⊗	9.3	0.0	0.0	3.0	8.6	29.3	50.0	0.0	0.0
- 2		13.3	0.0	0.0	3.0	14.4	30.0	50.0	0.0	0.0
- 3		11.7	0.7	6.7	3.0	0.0	0.0	0.0	0.7	6.7
- 5		14.0	0.0	0.0	2.3	2.6	7.2	7.2	0.0	0.0
- 6		14.3	0.0	0.0	2.7	42.2	70.8	81.3	0.0	0.0
- 7		14.7	0.0	0.0	2.7	4.8	32.6	36.9	0.0	0.0
- 8		11.0	0.0	0.0	3.0	33.2	63.4	66.7	0.0	0.0
-13		16.7	0.0	0.0	1.7	40.0	67.8	61.9	0.0	0.0
9835-# = RZM 8835mm⊗										
9835 - 1	RZM 8835mm⊗	16.7	0.7	3.7	1.7	0.0	0.0	0.0	0.7	3.7
- 2		12.3	0.0	0.0	3.0	0.0	8.3	5.6	0.0	0.0
- 3		12.7	0.0	0.0	3.0	0.0	0.0	3.3	0.0	0.0
- 4		16.3	0.7	3.9	2.0	0.0	0.0	0.0	0.0	0.0

TEST 1000. EVALUATION OF MONOGERM, S1 PROGENY LINES FROM RANDOM-MATED POPULATIONS FOR NONBOLTING, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count No.	Downey Mildew Count	DM Infection %	Emergence Score 12/21	% Bolting 06/28	% Bolting 08/01	% Bolting 08/22	Rhizoctonia No.	Rhizoctonia %
9835-# = RZM 8835mm⊗ (cont.)										
9835 - 5	RZM 8835mm⊗	16.0	1.0	6.3	2.3	0.0	2.0	6.4	1.3	8.2
- 6		14.0	1.0	7.0	3.0	2.2	4.4	9.0	0.0	0.0
- 7		13.7	0.0	0.0	3.0	0.0	0.0	0.0	0.3	2.4
- 8		14.3	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0
- 9		14.3	0.7	4.8	3.0	2.2	11.6	11.6	0.3	2.4
-10		16.0	0.3	2.0	3.0	20.9	39.8	41.8	0.3	2.0
-11		14.0	0.3	2.8	3.0	0.0	0.0	0.0	0.3	2.8
-12		15.0	0.3	2.0	2.7	0.0	0.0	4.5	0.3	2.0
-13		17.0	0.7	3.5	2.0	2.1	31.0	33.1	0.0	0.0
-15		15.3	0.0	0.0	2.3	0.0	0.0	0.0	0.3	2.2
-16		15.3	0.3	2.1	2.0	2.1	0.0	0.0	0.3	2.1
-17		12.0	0.7	5.1	3.0	16.9	47.4	46.7	0.0	0.0
-18		14.0	0.0	0.0	3.0	0.0	0.0	2.0	0.0	0.0
-19		13.3	0.3	2.6	3.0	7.5	7.5	10.1	0.7	5.1
-20		13.3	1.0	9.2	2.7	24.8	39.1	53.5	1.0	9.2
-21		14.7	0.0	0.0	2.7	48.2	72.3	69.9	0.0	0.0
-22		12.7	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0
-23		12.3	0.0	0.0	3.0	0.0	7.7	10.3	0.0	0.0
-24		13.7	0.0	0.0	3.0	0.0	0.0	0.0	0.3	2.6
-27		9.7	0.0	0.0	3.0	14.1	45.5	30.0	0.0	0.0
9836-# = RZM 8836mm⊗										
9836 - 1	RZM 8836mm⊗	12.7	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0
- 2		12.3	0.3	2.8	3.0	0.0	2.4	7.5	0.3	2.8
- 4		12.3	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0
- 6		13.7	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0

TEST 1000. EVALUATION OF MONOGERM, S1 PROGENY LINES FROM RANDOM-MATED POPULATIONS FOR NONBOLTING, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count No.	Downey Mildew Count	DM Infection %	Emergence Score 12/21	% Bolting 06/28	% Bolting 08/01	% Bolting 08/22	Rhizoctonia No.	Rhizoctonia %
9836-# = RZM 8836mm⊗ (cont.)										
9836 - 7	RZM 8836mm⊗	16.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0
- 8		15.7	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0
- 9		9.3	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0
-10		12.3	0.3	2.6	3.0	0.0	0.0	0.0	0.7	5.3
-11		14.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0
-12		16.0	0.7	3.3	2.7	0.0	0.0	0.0	0.0	0.0
-13		10.7	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0
-16		14.0	0.0	0.0	3.0	0.0	2.8	2.8	0.0	0.0
9838-# = RZM 8838mm⊗										
9838 - 1	RZM 8838mm⊗	15.0	0.0	0.0	3.0	12.9	13.1	15.2	0.0	0.0
- 2		15.7	1.0	6.4	2.7	0.0	4.4	4.4	0.0	0.0
- 4		13.7	3.7	29.5	3.0	0.0	0.0	2.8	0.3	2.6
- 8		0.3	-.-	-.-	4.3	-.-	-.-	-.-	-.-	-.-
9869-# = RZM 8869mm⊗										
9869 - 1	RZM 8869mm⊗	14.7	0.3	2.4	2.0	2.0	5.9	6.3	0.0	0.0
- 2		13.7	0.3	2.6	2.7	0.0	0.0	0.0	0.0	0.0
- 4		14.7	0.7	4.9	3.0	0.0	2.6	7.5	0.3	2.4
- 5		14.0	1.7	11.1	3.0	0.0	14.2	21.2	1.3	8.1
- 6		10.3	0.7	7.4	2.7	0.0	11.9	11.9	0.7	7.4
- 7		15.3	0.7	4.4	3.0	0.0	0.0	0.0	0.3	2.2
- 9		15.0	0.3	2.0	2.7	0.0	0.0	0.0	0.0	0.0
-10		16.7	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0
9869-# = RZM 8869mm⊗										
9869 -11	RZM 8869mm⊗	16.3	0.7	4.4	2.7	0.0	0.0	0.0	0.7	4.2
-12		16.3	1.7	11.1	2.0	13.2	37.5	31.9	0.0	0.0
-13		16.0	2.7	17.4	2.7	0.0	2.2	2.2	0.3	2.2
-14		15.0	0.3	2.2	2.7	0.0	0.0	2.1	0.0	0.0

TEST 1000. EVALUATION OF MONOGERM, S1 PROGENY LINES FROM RANDOM-MATED POPULATIONS FOR NONBOLTING, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count No.	Downey Mildew Count	DM Infection %	Emergence Score 12/21	% Bolting 06/28	% Bolting 08/01	% Bolting 08/22	Rhizoctonia No.	Rhizoctonia %
9815-# = 7815mm⊗										
9815 - 4	7815mm⊗	16.7	0.0	0.0	2.0	0.0	0.0	0.0	0.3	1.9
- 8		15.0	0.3	2.1	2.7	6.3	28.0	43.6	0.0	0.0
- 9		12.7	0.7	5.8	3.0	6.7	27.2	30.5	0.0	0.0
-11		13.7	1.0	7.1	3.0	4.2	18.2	18.2	1.0	7.1
9848-# = RZM 8848mm⊗										
9848 - 1	RZM 8848mm⊗	10.0	0.3	3.3	3.0	0.0	0.0	0.0	0.0	0.0
- 2		12.7	0.0	0.0	3.0	5.4	16.0	16.0	0.0	0.0
- 4		14.0	1.0	6.7	3.0	13.1	29.0	40.4	0.0	0.0
- 7		10.7	0.3	3.7	3.0	0.0	2.6	2.6	0.3	3.7
- 8		10.7	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0
- 9		14.0	1.3	8.9	3.0	0.0	5.0	7.2	0.7	5.0
-10		11.3	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0
-11		13.3	0.0	0.0	3.0	0.0	4.8	4.8	0.0	0.0
9810-# = RZM 8810mm⊗										
9810 - 1	RZM 8810mm⊗	13.0	1.3	11.4	3.0	0.0	0.0	0.0	0.7	5.8
- 2		10.7	1.3	16.5	3.0	4.8	7.0	7.0	0.3	2.2
- 3		11.3	3.0	28.0	3.0	2.4	0.0	0.0	1.7	16.3
- 5		12.0	1.3	10.7	3.0	0.0	0.0	5.3	0.0	0.0
- 6		14.0	1.7	12.2	3.0	2.2	2.2	2.2	1.3	10.0
- 7		11.3	0.3	3.7	3.3	0.0	0.0	2.8	0.7	6.5
- 8		13.3	2.0	14.3	2.7	0.0	0.0	0.0	1.0	7.1
- 9		12.0	0.0	0.0	3.0	0.0	2.2	2.2	0.0	0.0
-10		11.0	0.3	3.3	3.0	0.0	9.1	9.1	0.3	3.3
-11		13.7	0.3	2.6	3.0	2.6	5.1	12.8	0.3	2.6
-12		12.3	0.3	2.8	3.0	0.0	5.6	2.8	0.3	2.8
-13		11.7	0.0	0.0	3.0	5.9	9.2	9.2	0.3	2.8

TEST 1000. EVALUATION OF MONOGERM, S1 PROGENY LINES FROM RANDOM-MATED POPULATIONS FOR NONBOLTING, SALINAS, CA., 1999-2000

(cont.)

Variety	Description	Stand Count	Downey Mildew	DM Infection	Emergence Score	% Bolting			Rhizoctonia	
		No.	Count	%	12/21	06/28	08/01	08/22	No.	%
9810-# = RZM 8810mm⊗ (cont.)										
-14		14.3	0.3	2.6	3.0	0.0	9.4	9.4	0.7	5.1
-15		14.3	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0
-16		11.3	0.0	0.0	3.7	0.0	0.0	2.6	0.3	3.0
-20		13.3	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0
Mean		13.7	0.5	3.6	2.7	4.0	10.0	11.7	0.2	1.8
LSD (.05)		3.1	1.8	12.5	0.6	8.0	12.0	11.8	0.8	6.4
C.V. (%)		14.1	230.0	215.7	14.4	123.4	74.4	62.9	216.1	216.8
F value		4.9**	1.4*	1.6**	6.3**	10.3**	15.5**	18.6**	1.5**	1.6**

NOTES: Downy mildew was by natural infection. Emergence scored from 1 to 5 where 1 is best.

Rhizoctonia occurred as a cool season crown rot that destroyed the growing point and eventually lead to plant death. Counts were made May 9, 2000. This crown rot appeared to be similar to a winter/spring crown rot observed in Imperial Valley that caused damage on the same genotypes.

S_1 progeny lines were individual plants selected for resistance to rhizomania, monoger, and pollen fertility (A_). Simultaneously to selfing, crosses were made to an annual male sterile O-type tester. Based upon bolting, O-type, etc., the best progenies will be recombined.

Populations 8833 and 8835 were made to combine resistances to rhizomania and curly top. Population 8836, 8838, and 8869 were made to combine resistance to rhizomania, curly top, and virus yellows. Population 7815 = C890-4. 9848 and 9810 = C890-8 with rhizomania resistance from R22 (*Bvm*).

REACTION TO CERCOSPORA LEAF SPOT SALINAS LINES IN FORT COLLINS NURSERY, FORT COLLINS, CO, 2000

16 varieties x 3 reps, RCB — 2-row plots, 14 ft. long

Variety	Description	CR Rating 08/30	09/17	09/14
Checks				
Beta 4430R	susc. check, L4430.8052, 9-8-99	3.5	4.7	4.8
9931	RZM 8931aa x A	1.8	2.5	3.3
CR911H6	8833-5HO x CR811(C)	1.7	3.7	3.5
CR911(C)	CR811(C)aa x A	1.7	2.8	3.0
Half-sib progeny				
CR909-1	R709-1aa x CR811(C)	1.0	2.5	2.7
CR909-2	R709-1aa x CR811(C)	1.0	2.3	2.3
CR909-3	R709-1aa x CR811(C)	1.0	2.0	2.2
CR909-4	R709-1aa x CR811(C)	1.5	2.8	3.0
CR910-1	R710aa x CR811(C)	1.7	2.5	3.3
CR910-2	R710aa x CR811(C)	1.5	2.5	2.8
CR910-3	R710aa x CR911(C)	1.0	2.3	2.5
CR911-1	CR811aa x CR811(C)	1.7	2.5	3.0
CR911-2	CR811aa x CR811(C)	1.5	2.7	3.0
CR911-3	CR811aa x CR811(C)	1.8	3.3	3.7
CR911-4	CR811aa x CR811(C)	1.2	2.3	2.8
CR911-5	CR811aa x CR811(C)	1.3	2.7	2.8
FC Checks				
LSS		2.8	3.5	4.3
LSF		1.0	1.7	2.0
Mean		1.5	2.6	2.9
LSD (.05)		0.9	1.2	0.9

LSS = SP351069-0; LSR = (FC504 x FC502/2) x SP22-0

REACTION TO CERCOSPORA LEAF SPOT SALINAS LINES IN BETASEED NURSERY, SHAKOPEE, MN, 2000

16-20 grams/entry, raw, whole seed, not treated

Planted: March 20, 2000

Variety	Description	CR Rating 07/27	08/04	08/11	08/18	08/25	Mean
USDA Entries							
97-SP22-0	Inc.SP7622-0 (CLSR,Aph.R.Ck)	2.0	1.8	3.0	4.0	5.3	3.2
B4430R	3-10-97 (CLSS ck)	2.8	2.6	5.5	7.6	9.1	5.5
99-EL-02/04	RZM 98-EL-02,-04 (SR)	2.0	1.9	4.2	5.3	6.3	3.9
99-FC-1,2,3M	RZM-ER-% FC-1,2,3 (CR)	2.3	1.9	4.5	6.5	7.6	4.5
R926	RZM R626, (C26)	2.0	1.8	4.5	5.8	7.0	4.2
R978	RZM-ER-% R778, (C78)	2.3	2.0	4.5	5.9	7.2	4.4
Y969 (Iso)	RZM-ER-% Y769, (C69)	2.3	1.8	5.0	6.2	7.3	4.5
9931	RZM 8931aa x A	2.0	1.4	5.0	6.5	7.6	4.5
9933	8933aa x A, (RAR)	2.0	1.9	5.5	6.3	7.1	4.5
8835	8835mmaa x A, (CTR)	2.0	1.7	5.0	5.9	7.5	4.4
9833-5	RZM 8835-5, (C833-5)	2.3	2.0	5.2	6.2	7.6	4.6
CR909-01	RZM R709-1, (CR09)	2.0	1.3	4.1	5.3	7.4	4.0
CR910	RZM R710,…	1.5	1.4	3.3	4.6	5.3	3.2
CR911(C)	CR811(C)aa x A, (CR09,10)	2.0	1.5	4.3	5.6	6.5	4.0
CR911H6	8833-5H50 x CR811(C)	2.0	1.8	4.5	5.8	6.8	4.2
CR911-1(Sp)	CR811aa x CR811(C)	1.5	1.5	3.8	4.8	6.4	3.6
CR911-2(Sp)	CR811aa x CR811(C)	2.0	1.3	4.0	5.7	6.8	4.0
CR911-3(Sp)	CR811aa x CR811(C)	2.0	1.7	3.8	4.7	6.8	3.8
CR911-4(Sp)	CR811aa x CR811(C)	2.0	1.7	3.8	5.0	6.3	3.8
CR811-5(Sp)	CR811aa x CR811(C)	2.0	1.5	3.5	5.1	6.0	3.6
Checks							
BTS Resistant Hybrid		1.8	1.5	3.2	3.9	5.0	3.1
USDA Resistant Hybrid		1.3	1.1	2.3	3.0	3.1	2.1
Susc. Hybrid Check 1		2.3	2.0	5.3	7.2	9.0	5.1
Susc. Hybrid Check 2		2.3	2.0	4.8	6.8	8.3	4.8
Check Mean		1.8	1.5	3.6	4.8	6.3	3.6
Grand Mean		1.9	1.6	3.8	5.2	6.5	3.8
LSD (.05)		0.9	0.4	0.7	0.8	0.8	0.5

EVALUATION OF PAIRCROSSES (FULL SIBS) OF C78 & C80, SALINAS, CA., 2000

(TESTS 1300, 300, 5300)

	Test 1300 (VY)				Test 300 (NB)		Test 5300 (RZM)		
Variety	Sugar Yield	Sucrose	RJAP	Powdery Mildew	% Bolting	%Downey Mildew	Sugar Yield	Sucrose	RJAP
	Lbs	%	%	Score	10/10	04/03	Lbs	%	%
Checks									
R978	19100	17.00	83.2	3.7	13.5	0.0	8884	18.37	83.4
R980	17798	17.43	83.4	5.0	21.6	0.0	8490	18.60	83.9
97-SP22-0	15738	16.17	81.9	4.7					
97-US75	17707	16.17	82.4	7.3					
97-US22/3					90.9	1.9			
SS-NB3					21.6	0.0			
B4776R							9812	17.97	86.1
US H11							5146	16.57	86.4
R978-# = RZM R878%(PX)									
R978 - 1	17126	17.23	82.7	1.0	17.7	4.6	8371	18.27	82.8
- 2	18183	17.23	83.9	1.3	4.2	10.4	9458	18.27	83.0
- 3	19408	16.97	83.3	2.0	2.0	6.3	11319	18.07	84.8
- 4	18109	17.27	82.1	2.7	15.0	4.4	10267	18.60	83.9
- 5	20652	16.90	83.9	1.7	0.0	1.7	8633	18.63	85.2
- 6	19523	17.27	85.6	2.3	1.9	4.4	8595	17.97	86.0
- 7	16728	17.20	83.8	3.7	44.5	30.5	9740	17.90	84.0
- 8	18920	16.60	82.4	2.3	34.4	6.7	9729	18.10	85.2
- 9	18795	17.13	82.4	4.0	2.2	0.0	7358	18.67	85.5
-10	18646	16.87	82.3	7.0	12.9	5.3	6991	18.40	83.5
-11	21077	17.07	83.8	1.3	0.0	0.0	8063	18.27	84.4
-12	16302	16.97	85.6	2.0	37.2	3.5	9543	18.60	84.2
-13	18333	17.17	82.8	3.3	57.1	0.0	8426	18.17	84.4
-14	17441	16.63	80.5	2.0	76.0	0.0	8647	18.07	82.9
-15	17435	16.63	81.0	1.3	5.5	0.0	8491	18.57	81.8
-16	22328	17.03	83.0	3.7	48.7	1.9	11426	18.67	85.6

EVALUATION OF PAIRCROSSES (FULL SIBS) OF C78 & C80, SALINAS, CA., 2000
(TESTS 1300, 300, 5300)

(cont.)

	Test 1300 (VY)				Test 300 (NB)		Test 5300 (RZM)		
Variety	Sugar Yield	Sucrose	RJAP	Powdery Mildew	% Bolting	%Downey Mildew	Sugar Yield	Sucrose	RJAP
	Lbs	%	%	Score	10/10	04/03	Lbs	%	%
R978-# = RZM R878%(PX) (cont.)									
R978 -17	19941	17.27	84.6	2.3	70.4	0.0	8514	18.13	84.0
-18	19282	17.00	82.3	3.3	12.0	3.9	8559	18.27	86.5
-19	19675	16.87	82.3	4.3	34.6	0.0	10446	18.27	83.6
-20	18202	16.30	80.3	1.7	50.9	2.4	11564	18.20	85.9
-21	19398	16.23	82.3	2.0	88.9	3.7	6696	18.73	84.4
-22	14841	16.73	82.7	1.3	15.5	4.2	8999	18.80	85.3
-23	18276	16.90	84.5	3.0	95.4	2.8	8804	18.33	86.7
-24	18995	17.00	83.7	1.3	25.6	8.3	9128	18.57	84.2
-25	19451	16.70	84.1	4.7	4.8	0.0	7386	18.00	84.6
-26	20622	16.57	84.5	5.7	76.9	5.1	8730	18.13	86.9
-27	18310	16.83	84.4	3.0	22.5	2.6	5764	17.80	83.8
-28	16458	16.47	83.9	2.0	37.5	14.8	8569	18.57	85.2
-29	15979	15.70	82.5	1.0	60.1	6.7	6279	18.90	86.3
-30	16215	16.07	83.4	1.7	23.4	3.2	8166	18.33	85.8
-31	18250	16.57	84.8	2.3	5.4	2.4	7345	18.20	85.9
-32	16471	17.40	81.7	2.7	0.0	2.8	8520	18.83	81.3
-33	17010	16.37	81.6	5.7	84.6	8.3	5500	18.37	83.3
-34	20915	17.33	83.2	3.0	49.4	9.5	10199	18.17	82.3
-35	20320	16.47	81.0	1.0	42.2	2.2	8993	18.33	82.1
-36	19111	16.53	80.9	1.7	95.1	5.1	9307	18.07	83.7
R980-# = RZM R880 (PX)									
R980 - 1	18778	16.97	83.6	3.0	11.8	0.0	5223	17.63	83.0
- 2	17142	16.83	82.1	3.0	73.4	5.3	7859	18.00	84.7
- 3	16257	16.63	82.3	5.3	33.5	6.4	7781	17.77	86.2
- 4	19641	15.90	83.7	5.3	44.4	2.2	11507	17.13	84.1

EVALUATION OF PAIRCROSSES (FULL SIBS) OF C78 & C80, SALINAS, CA., 2000
(TESTS 1300, 300, 5300)

(cont.)

Variety	Test 1300 (VY) Sugar Yield Lbs	Test 1300 (VY) Sucrose %	Test 1300 (VY) RJAP %	Test 1300 (VY) Powdery Mildew Score	Test 300 (NB) % Bolting 10/10	Test 300 (NB) %Downey Mildew 04/03	Test 5300 (RZM) Sugar Yield Lbs	Test 5300 (RZM) Sucrose %	Test 5300 (RZM) RJAP %
R980-# = RZM R880 (PX) (cont.)									
R980 - 5	18532	16.47	81.4	1.7	7.0	6.5	8116	18.33	84.8
- 6	17561	15.20	84.0	5.7	65.3	5.9	9669	16.83	83.7
- 7	16390	16.83	81.0	4.3	17.5	2.4	7114	17.37	82.1
- 8	20132	16.70	82.4	4.0	9.7	1.9	9919	17.67	84.2
R980 - 9	18029	16.93	82.6	5.3	20.1	0.0	8541	17.77	84.4
-10	18352	17.07	79.0	5.0	13.5	0.0	9968	18.67	81.4
-11	21922	17.47	83.1	6.3	6.7	0.0	8452	18.60	83.2
-12	20082	16.27	81.3	2.3	23.6	2.0	8440	18.37	84.7
-13	18347	15.73	83.5	5.7	28.5	0.0	9104	18.00	86.1
-14	21075	15.93	83.6	4.0	20.3	0.0	9353	17.10	82.4
-15	17903	16.47	83.4	5.7	23.3	0.0	8375	18.47	85.1
-16	18335	17.13	82.4	6.3	0.0	2.0	10095	18.00	86.0
-17	18616	15.40	82.6	4.3	22.2	2.6	11233	17.07	87.2
-18	18743	17.23	80.4	5.3	27.8	2.4	7195	18.87	82.1
-19	17865	16.90	82.0	4.7	31.3	2.6	7531	17.87	83.9
-20	19455	17.57	80.7	2.0	0.0	0.0	7013	18.20	79.0
-21	20752	17.60	84.0	3.7	2.2	4.4	10209	18.27	82.9
-22	21137	16.70	83.4	3.7	79.0	3.3	9182	17.83	84.7
-23	18944	17.40	80.3	2.7	11.1	0.0	8482	18.30	83.8
-24	19641	17.40	83.3	6.0	22.6	0.0	8591	18.23	83.9
Mean	18604.8	16.77	82.7	3.5	31.2	3.4	8653.3	18.16	84.3
LSD (.05)	3602.7	0.76	2.3	2.2	22.8	13.4	3596.0	0.80	2.9
C.V. (%)	12.0	2.79	1.7	39.3	45.2	242.3	25.7	2.72	2.2
F value	1.5*	3.72**	2.7**	4.6**	11.6**	0.9NS	1.3NS	2.88**	2.2**

EVALUATION OF PAIRCROSSES (FULL SIBS) with C31Rz GERMPLASM, SALINAS, CA., 2000

(TESTS 1400, 400, 5400)

	Test 1400 (VY)				Test 400 (NB)		Test 5400 (RZM)		
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	% Bolting 10/10	%Downey Mildew 04/03	Sugar Yield Lbs	Sucrose %	RJAP %
Checks									
Y969 (Iso)	19849	17.37	81.5	4.3	45.4	0.0	9074	18.40	84.2
R876-89-5NB	16916	17.53	83.0	3.7	23.2	0.0	8281	18.30	84.8
Beta 4776R	19606	17.93	85.3	5.0			11375	18.17	87.1
99-C31/6	17283	16.97	81.7	5.0			5716	17.30	85.4
99-C37					1.7	2.0			
97-SP22-0					98.1	5.8			
Y969-# = RZM Y869(PX)									
Y969 - 1	21208	17.07	84.9	3.7	93.0	5.1	12460	17.77	84.9
- 2	19334	16.73	82.9	2.7	62.2	1.9	8211	17.93	85.5
- 3	19137	16.70	84.1	4.0	30.1	13.6	8698	17.63	86.9
- 4	19624	17.43	83.4	5.7	12.5	4.2	8655	17.87	85.1
- 5	19081	17.13	83.2	5.7	6.4	19.5	8259	17.07	86.1
- 6	17988	17.10	81.8	4.3	37.5	7.8	8450	17.60	84.3
- 7	18987	17.50	83.5	3.7	91.7	6.3	7505	17.93	85.4
- 8	15632	16.83	78.1	3.0	44.7	2.2	4548	17.93	79.3
- 9	17969	16.63	84.1	4.7	27.5	16.7	9049	18.03	86.4
-10	15368	16.83	81.4	5.3	58.8	6.3	8482	18.20	83.1
-11	17529	16.37	84.8	5.0	29.5	12.7	7511	17.73	84.4
-12	19392	17.27	84.0	4.7	30.7	4.4	7785	17.60	84.8
-13	16819	16.53	82.8	3.3	37.5	5.9	7616	17.40	85.4
-14	18720	16.87	84.2	3.3	88.6	0.0	7954	18.40	85.9
-15	20443	17.47	83.8	3.7	70.6	0.0	8493	18.77	83.3
-16	17560	16.67	82.4	4.0	15.7	4.4	7920	17.87	84.4
-17	19414	16.63	81.9	5.0	92.7	0.0	9097	17.70	84.3
-18	18226	16.93	81.9	4.7	83.5	0.0	6278	18.00	82.5
-19	17119	17.50	83.3	5.7	29.4	2.0	6443	17.93	83.6
-20	19879	16.93	83.3	4.0	68.8	0.0	7937	17.60	84.6
-21	19528	17.70	83.9	3.7	44.4	0.0	8901	17.70	83.8
-22	19783	16.83	85.3	4.3	68.6	8.4	8783	18.20	83.1

EVALUATION OF PAIRCROSSES (FULL SIBS) with C31*Rz* GERMPLASM, SALINAS, CA., 2000

(TESTS 1400, 400, 5400)

(cont.)

	Test 1400 (VY)				Test 400 (NB)		Test 5400 (RZM)		
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	% Bolting 10/10	%Downey Mildew 04/03	Sugar Yield Lbs	Sucrose %	RJAP %
Y968-# = RZM Y868(PX)									
Y968 - 1	15909	17.87	83.7	4.7	19.2	2.0	7341	18.63	83.9
- 2	19176	17.80	82.8	4.0	5.6	2.0	9208	17.97	84.2
- 3	17849	17.13	82.9	5.7	16.4	0.0	6797	17.23	85.0
- 4	17318	16.87	84.3	4.3	50.9	0.0	7293	17.67	84.9
- 5	19691	17.67	85.2	5.0	39.8	3.7	8661	18.40	85.4
- 6	18875	17.10	83.4	3.3	24.5	0.0	7279	18.10	84.9
- 7	18521	17.30	81.5	5.3	5.7	1.8	8151	18.40	82.4
- 8	18666	17.77	84.5	5.0	6.1	2.2	7589	18.53	84.8
- 9	15291	16.40	82.4	4.0	5.3	0.0	7411	18.13	85.0
-10	18066	16.80	82.5	3.3	25.3	0.0	8014	18.03	84.5
-11	15965	16.77	84.4	3.3	2.2	0.0	9576	18.20	84.3
-12	17230	15.90	83.1	4.7	4.5	0.0	8066	17.67	85.8
-13	19342	17.77	82.0	4.0	2.6	0.0	8443	18.90	84.6
-14	18461	16.80	82.9	3.3	44.9	0.0	7514	18.07	86.6
-15	17406	17.93	83.8	3.7	37.2	1.9	7646	18.53	83.4
-16	17751	18.13	84.1	3.7	7.7	2.4	9349	18.80	82.9
-17	19744	17.33	84.6	6.0	24.7	0.0	7495	17.80	83.4
R981-# = RZM R881(PX)									
R981 - 1	18851	16.50	83.5	5.3	3.9	0.0	9231	16.97	84.0
- 2	17779	16.10	85.8	4.7	5.9	7.8	9760	17.27	87.6
- 3	17232	15.97	82.2	6.3	35.3	2.0	9171	17.70	87.8
- 4	20043	16.30	84.6	6.0	18.5	14.8	8530	15.83	84.8
- 5	15116	15.87	80.8	5.7	38.4	0.0	7544	18.47	84.2
- 6	19719	16.90	83.7	4.7	32.7	1.8	10418	18.07	85.1

EVALUATION OF PAIRCROSSES (FULL SIBS) with C31*Rz* GERMPLASM, SALINAS, CA., 2000

(TESTS 1400, 400, 5400)

(cont.)

Variety	Test 1400 (VY) Sugar Yield Lbs	Test 1400 (VY) Sucrose %	Test 1400 (VY) RJAP %	Test 1400 (VY) Powdery Mildew Score	Test 400 (NB) % Bolting 10/10	Test 400 (NB) %Downey Mildew 04/03	Test 5400 (RZM) Sugar Yield Lbs	Test 5400 (RZM) Sucrose %	Test 5400 (RZM) RJAP %
R981-# = RZM R881(PX) (cont).									
R981 - 7	17938	15.60	79.5	5.7	38.1	2.2	8529	17.37	85.0
- 8	16842	16.13	83.0	4.7	44.2	0.0	9703	17.47	86.3
- 9	18030	16.03	83.2	3.7	12.6	6.3	9082	17.40	85.1
-10	16993	16.33	82.8	3.7	66.3	0.0	8291	18.30	82.7
-11	17472	15.13	83.0	4.7	74.5	0.0	9832	17.57	83.5
-12	17883	15.63	83.2	5.0	20.3	8.9	8619	17.90	84.6
-13	17505	15.33	81.9	4.3	42.5	9.6	8546	17.70	85.4
-14	20037	15.50	81.4	5.7	57.4	0.0	9624	17.13	86.3
-15	15400	16.20	82.2	5.3	3.8	6.0	8698	17.80	85.2
-16	17719	15.40	81.5	6.3	2.0	2.4	8203	17.30	85.1
-17	19732	16.37	83.6	4.0	5.6	1.9	9015	17.40	83.6
-18	20792	15.77	83.6	5.7	23.3	0.0	8298	16.37	86.0
-19	16808	16.60	85.3	4.7	6.1	2.2	6843	18.03	86.0
-20	17787	16.43	83.8	6.0	1.9	6.3	9852	17.50	85.0
-21	18342	17.80	83.6	4.3	39.8	0.0	7625	18.50	85.8
-22	19562	17.80	83.6	4.3	0.0	0.0	11186	18.23	85.3
-23	18785	15.80	82.5	4.7	62.0	0.0	9118	17.23	84.4
-24	18046	16.37	83.5	4.7	25.4	0.0	8890	18.40	86.3
-25	16425	15.87	83.5	5.0	0.0	2.0	8199	17.73	84.5
-26	17443	15.63	82.3	4.3	40.7	16.5	7700	17.33	86.0
-27	17014	15.10	83.1	5.7	16.2	6.8	10530	17.67	86.1
-28	18676	16.17	82.9	6.0	32.9	10.9	6449	17.60	84.3
-29	17613	16.07	84.1	6.3	66.6	0.0	8119	17.77	85.8
-30	16885	15.27	82.5	5.3	41.7	2.6	6922	17.67	84.1
-31	18130	14.87	82.8	5.0	58.5	4.4	8017	16.40	85.9
-32	18214	16.00	83.2	5.3	99.5	5.6	9130	17.77	82.9

EVALUATION OF PAIRCROSSES (FULL SIBS) with C31Rz GERMPLASM, SALINAS, CA., 2000

(TESTS 1400, 400, 5400)

(cont.)

	Test 1400 (VY)				Test 400 (NB)		Test 5400 (RZM)		
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	% Bolting 10/10	%Downey Mildew 04/03	Sugar Yield Lbs	Sucrose %	RJAP %
R981-# = RZM R881(PX) (cont.)									
R981 -33	18451	15.83	82.9	7.3	62.7	8.4	9875	17.97	85.7
-34	18537	16.70	83.1	5.7	0.0	3.0	9174	17.87	83.5
-35	17539	15.73	82.4	5.7	10.5	8.9	8546	16.97	85.7
-36	17726	15.60	82.8	6.3	47.5	9.4	9460	16.00	85.4
-37	19795	16.60	84.0	5.0	70.0	7.8	9486	17.70	85.2
R976-89-5NB-# = RZM R876-89-5NB(PX)									
R976-89-5NB- 1	21962	17.40	83.5	10.4	4.2	6675	18.47	82.4	
- 2	18321	17.93	82.6	4.0	15.3	1.8	8206	18.57	82.9
- 3	17015	17.47	83.8	4.7	5.9	0.0	7011	18.60	83.0
- 4	17201	17.37	81.9	3.7	1.9	2.2	9116	18.77	84.6
- 5	16842	18.13	82.4	4.7	11.5	0.0	4905	19.47	82.0
- 6	21050	18.43	86.4	4.7	30.8	1.9	7452	18.67	83.5
- 7	16006	17.57	82.2	5.0	27.0	0.0	6163	19.50	82.4
- 8	14576	17.13	83.4	5.0	9.5	0.0	5052	18.97	82.6
- 9	20231	16.87	83.6	4.0	19.4	0.0	7409	18.53	83.9
-10	13853	16.40	80.5	4.7	27.1	2.2	6747	18.90	83.2
-11	15247	17.00	81.9	3.7	7.1	2.1	7300	19.20	85.4
-12	17084	17.23	82.1	3.3	25.8	0.0	5231	19.20	82.7
-13	14490	17.43	80.2	4.0	23.4	0.0	4575	19.07	83.3
-14	18055	17.93	81.3	4.3	10.7	0.0	5948	19.13	82.2
-15	18812	18.37	81.8	4.3	4.3	0.0	5010	18.80	81.0
-16	17421	17.60	81.8	4.3	44.6	0.0	8272	18.67	81.0
-17	18495	18.10	83.3	4.7	21.8	0.0	5820	18.90	82.2
-18	17286	17.67	81.3	4.0	23.2	0.0	7430	18.63	83.2
-19	15306	17.40	84.1	3.3	71.9	0.0	6353	18.97	82.6

EVALUATION OF PAIRCROSSES (FULL SIBS) with C31*Rz* GERMPLASM, SALINAS, CA., 2000

(TESTS 1400, 400, 5400)

(cont.)

Variety	Test 1400 (VY)				Test 400 (NB)		Test 5400 (RZM)		
	Sugar Yield	Sucrose	RJAP	Powdery Mildew	% Bolting	%Downey Mildew	Sugar Yield	Sucrose	RJAP
	Lbs	%	%	Score	10/10	04/03	Lbs	%	%
R976-89-5-# = RZM R876-89-5(PX)									
R976-89-5 - 1	16191	17.33	82.7	4.0	28.2	0.0	7963	18.83	82.5
- 2	17322	17.13	81.8	4.0	2.2	0.0	8226	18.47	80.8
- 3	17743	17.57	84.5	3.3	11.1	0.0	6131	18.80	84.7
- 4	20568	17.60	82.4	4.0	0.0	0.0	8702	19.03	82.4
- 5	14555	16.33	78.0	3.7	2.4	0.0	7284	17.53	79.2
- 6	16508	18.17	83.5	3.7	31.7	0.0	8531	19.90	85.0
- 7	17361	16.73	82.6	3.7	38.4	0.0	7706	18.67	83.3
- 8	16182	16.87	81.9	4.7	14.9	0.0	8540	18.83	84.7
- 9	19855	17.63	83.2	5.7	5.6	0.0	7717	18.10	85.4
-10	16704	17.23	81.8	4.3	18.9	0.0	6064	18.77	82.1
-11	18027	17.70	81.7	3.7	12.2	0.0	5633	18.83	82.7
-12	16574	17.57	83.0	4.3	2.4	0.0	4691	18.77	80.8
-13	16231	17.50	82.8	4.0	4.8	0.0	7851	19.27	84.0
Mean	17925.0	16.87	82.9	4.6	30.2	2.8	7993.3	18.08	84.3
LSD (.05)	2975.6	0.87	2.8	1.3	19.3	9.2	2933.7	0.83	2.7
C.V. (%)	10.3	3.19	2.1	17.5	39.6	201.3	22.8	2.86	2.0
F value	2.2**	6.81**	1.9**	3.7**	14.1**	1.6**	1.9**	5.76**	2.8**

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH RHIZOMANIA RESISTANCE FROM *BETA MARITIMA*, SALINAS, CA., 2000

(TESTS 1500, 500, 5500, B900, B1300)

Variety	Test 1500 Sugar Yield Lbs	Test 1500 Sucrose %	Test 1500 RJAP %	Test 1500 Powdery Mildew Score	Test 500 % Bolting 10/10	Test 500 %Downey Mildew 04/03	Test 5500 Sugar Yield Lbs	Test 5500 Sucrose %	Test 5500 RJAP %
Checks									
97-SP22-0	15654	16.33	82.0	5.3	98.0	0.0			
Y967	20041	17.10	81.1	5.0	37.2	0.0	11750	17.93	84.8
Y971	20182	17.00	82.7	8.3	21.5	1.9	9920	17.03	83.6
99-C37	16387	16.80	83.3	9.0	0.0	5.7	5299	17.13	81.9
R936							9245	16.40	83.8
R967-# = RZM R867(PX)									
Y967 - 1	18317	16.43	84.3	4.7	29.5	2.0	10473	17.03	85.7
- 2	16600	16.70	83.2	2.7	9.7	0.0	7609	16.73	85.6
- 3	17787	17.43	81.1	6.0	25.3	0.0	9881	17.67	82.8
- 4	15628	17.30	83.6	8.0	48.8	2.2	9925	18.07	84.0
- 5	18458	17.93	83.3	2.7	28.1	0.0	10745	18.27	83.7
- 6	18604	16.90	80.5	2.0	79.5	2.6	8431	17.80	81.7
- 7	18534	15.97	82.4	5.7	33.0	0.0	10434	17.63	83.8
- 8	17239	16.63	83.9	6.7	25.6	0.0	10897	17.67	82.9
- 9	17913	16.40	83.0	2.7	20.3	0.0	9626	17.37	85.3
-10	18702	16.27	83.0	1.3	52.4	0.0	7580	17.63	83.3
Y972-# = RZM Y872(PX)									
Y972 - 1	21760	17.50	83.5	7.0	42.4	4.3	11276	17.93	84.5
- 2	20954	16.20	83.5	3.7	36.7	0.0	9309	17.30	83.7
- 3	21749	15.87	84.3	2.7	23.7	2.6	9847	17.10	84.7
- 4	17672	15.83	81.1	5.7	8.1	2.6	10220	17.17	82.7
- 5	18358	17.00	83.2	4.7	3.9	2.1	10182	17.77	83.5
- 6	18830	16.30	81.0	8.0	33.5	0.0	8875	17.53	83.2
- 7	18328	17.40	82.6	4.0	1.8	0.0	10610	18.27	82.8
- 8	21044	16.80	85.6	6.7	20.9	6.7	12001	17.47	84.1

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH RHIZOMANIA RESISTANCE FROM *BETA MARITIMA*, SALINAS, CA., 2000

(TESTS 1500, 500, 5500, B900, B1300)
(cont.)

	Test 1500				Test 500		Test 5500		
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	% Bolting 10/10	%Downey Mildew 04/03	Sugar Yield Lbs	Sucrose %	RJAP %
Y975-# = RZM Y875(PX)									
Y975 - 1	18718	16.13	83.9	8.3	2.2	2.4	7301	17.03	85.6
- 2	18606	16.27	82.7	7.7	37.3	0.0	6464	18.33	85.1
- 3	17804	16.17	82.3	5.7	27.0	2.2	10840	16.83	85.0
- 4	19526	17.37	79.7	2.7	3.9	0.0	10814	18.47	83.8
- 5	18224	16.47	82.3	9.0	71.6	2.8	11494	17.10	85.7
- 6	17540	16.50	81.6	1.3	12.8	5.0	8401	17.73	81.8
- 7	18620	15.97	83.3	8.3	64.6	2.4	7560	17.87	84.4
- 8	19625	17.23	79.5	3.3	72.2	19.3	8840	18.83	83.1
- 9	17763	16.30	82.6	2.3	2.2	13.3	6384	17.77	82.9
-10	18641	16.43	83.3	7.3	79.0	13.5	7636	17.37	84.6
-11	16364	16.37	82.9	2.0	18.4	11.7	11123	17.77	85.9
-12	17241	16.43	80.6	6.3	45.6	12.5	9830	18.40	83.9
-13	19926	17.13	81.7	2.3	47.1	18.4	11823	17.57	82.4
-14	18431	15.13	80.1	5.7	9.2	22.6	8611	17.30	85.5
-15	19804	16.60	83.1	6.7	33.1	12.6			
-16	22136	15.60	82.6	9.0	17.1	1.8			
-17	17388	16.03	80.8	4.3	36.2	30.8			
-18	18568	15.60	81.3	7.7	19.9	37.5			
-19	15457	16.57	82.2	2.7	23.2	7.0			
-20	19307	16.33	84.0	1.7	40.5	19.2			
-21	17761	16.63	83.9	8.3	19.3	5.8			
-22	16606	16.27	83.8	7.0	82.4	0.0			
-23	17318	16.20	80.9	2.3	57.1	0.0			
-24	18171	15.63	83.8	5.0	56.8	0.0			
-25	18705	15.73	84.2	7.7	88.4	6.5			
-26	20401	16.10	82.9	8.0	31.3	0.0			

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH RHIZOMANIA RESISTANCE FROM *BETA MARITIMA*, SALINAS, CA., 2000

(TESTS 1500, 500, 5500, B900, B1300)
(cont.)

Variety	Test B900					Test B1300	
	Sugar Yield	Sucrose	Bolting	Root Rot	Appearance Score	Segregation Pattern	Appearance Score
	Lbs	%	%	%	5/17	range	5/18
Checks							
97-SP22-0							
Y967	8798	14.80	0.0	1.7	2.0	1 - 4	3.0
Y967						1 - 4	2.0
Y971	9370	14.38	0.0	0.0	1.0		
99-C37						4 - 5	5.0
99-C37						4 - 5	5.0
R936						2 - 3	2.0
R936						2 - 3	1.0
B4776R	4566	13.99	0.0	3.6	4.0		
9934	6951	14.70	4.0	3.3	3.0		
R967-# = RZM R867(PX)							
Y967 - 1	9117	14.25	0.0	0.0	1.5	4	3.0
- 2	7878	14.72	0.0	0.0	2.0	3 - 4	3.0
- 3	10772	16.08	0.0	0.0	1.5	2 - 3	2.0
- 4	8411	16.65	0.0	0.0	2.0	3	2.0
- 5	9640	15.90	0.0	0.0	2.0	2 - 3	2.0
- 6	7109	16.00	11.5	0.0	3.5	2 - 3	3.0
- 7	8034	16.41	0.0	0.0	3.0	2 - 3	1.0
- 8	8576	16.41	0.0	0.0	2.5	2	1.0
- 9	10730	15.87	0.0	0.0	2.0	3	2.0
-10	9816	16.35	0.0	0.0	2.5	3	2.0
Y972-# = RZM Y872(PX)							
Y972 - 1	9873	15.85	0.0	0.0	1.5	2	1.0
- 2	9387	14.76	0.0	1.9	2.0	2 - 3	3.0
- 3	8761	15.60	0.0	0.0	2.5	3	3.0
- 4	8714	15.42	0.0	0.0	2.0	2 - 4	3.0

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH RHIZOMANIA RESISTANCE FROM *BETA MARITIMA*, SALINAS, CA., 2000

(TESTS 1500, 500, 5500, B900, B1300)
(cont.)

	Test B900					Test B1300	
Variety	Sugar Yield Lbs	Sucrose %	Bolting %	Root Rot %	Appearance Score 5/17	Segregation Pattern range	Appearance Score 5/18
Y972-# = RZM Y872(PX) (cont.)							
Y972 - 5	8401	16.13	0.0	0.0	2.5	2 - 4	3.0
- 6	8828	15.77	0.0	0.0	2.0	2 - 4	3.0
- 7	9371	17.01	0.0	0.0	2.5	2 - 3	2.0
- 8	11567	15.28	0.0	0.0	2.0	2 - 3	2.0
Y975-# = RZM Y875(PX)							
Y975 - 1	6127	13.99	0.0	20.0	4.0	3	2.0
- 2	4939	15.46	0.0	7.1	4.5	5	5.0
- 3	11118	14.48	0.0	3.7	3.0	2 - 4	3.0
- 4	5799	15.27	0.0	0.0	3.5	3	3.0
- 5	8818	15.17	4.8	0.0	2.5	3	3.0
- 6	5386	15.41	0.0	7.4	3.0	3	2.0
- 7	7878	15.10	0.0	10.7	3.0	3	2.0
- 8	6703	14.94	3.8	5.4	3.0	1 - 4	1.0
- 9	10231	15.60	0.0	2.2	2.5	3	2.0
-10	9718	14.86	0.0	0.0	3.0	3	2.0
-11	9688	15.45	0.0	0.0	2.0	1 - 2	1.0
-12	8048	16.56	2.1	3.7	3.0	3	4.0
-13	13025	16.18	0.0	0.0	1.0	1 - 2	1.0
-14	5873	15.59	0.0	2.0	4.0	4	5.0
-15	11318	15.57	0.0	0.0	2.0	1 - 3	2.0
-16	4316	15.27	0.0	5.4	4.0	4	4.0
-17	11086	15.24	0.0	0.0	2.0	1	1.0
-18	9326	16.23	0.0	3.6	3.0	1 - 4	1.0
-19	8429	16.41	0.0	1.7	3.0	1 - 4	2.0
-20	9244	14.81	0.0	0.0	2.5	1 - 2	1.0

EVALUATION OF PAIRCROSSES (FULL SIBS) WITH RHIZOMANIA RESISTANCE FROM *BETA MARITIMA*, SALINAS, CA., 2000

(TESTS 1500, 500, 5500, B900, B1300)
(cont.)

	Test B900					Test B1300	
Variety	Sugar Yield	Sucrose	Bolting	Root Rot	Appearance Score	Segregation Pattern	Appearance Score
	Lbs	%	%	%	5/17	range	5/18
Y975-# = RZM Y875(PX) (cont.)							
Y975 -21						2 - 3	3.0
-22						1 - 2	2.0
-23						1 - 2	2.0
-24						2 - 4	3.0
-25						1	1.0
-26						1 - 4	3.0

EVALUATION OF MULTIGERM S_n PROGENY LINES FROM F_2 POPNS DERIVED FROM F_1 HYBRIDS, SALINAS, CA., 2000

(TESTS 1600, 600, 5600)

	Test 1600 (VY)				Test 600 (NB)		Test 5600 (RZM)		
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	% Bolting 10/10	%Downey Mildew 04/03	Sugar Yield Lbs	Sucrose %	RJAP %
Checks									
8935(Iso)	14107	15.87	82.1	7.0	5.6	0.0	7131	17.17	83.0
8936	16340	16.03	80.3	5.3	11.1	1.9	11775	17.33	84.4
8939	16447	16.33	82.8	3.3	24.5	2.0	7790	17.00	84.3
97-SP22-0	14061	15.90	81.5	4.0	89.9	0.0			
US H11							4689	15.20	86.2
9935-# = RZM 8935(Iso)⊗; = RZM R776-89-5H13									
9935 - 1	16365	15.83	81.3	3.7	2.6	0.0	8808	17.00	85.7
- 2	13041	16.67	79.0	2.7	0.0	2.1	6330	18.63	81.2
- 3	15987	15.70	82.0	3.7	5.6	0.0	5544	17.43	83.9
- 4	14677	16.37	84.8	5.3	51.8	8.3	5098	17.80	84.0
- 5	13692	15.73	79.3	7.3	0.0	2.2	5067	17.07	84.1
- 6	13439	17.40	81.7	0.7	0.0	12.5	6791	19.27	83.4
- 7	15777	15.93	84.3	5.7	40.4	2.2	6742	16.90	84.5
- 8	14707	17.23	82.3	8.3	0.0	3.7	2510	17.77	84.7
- 9	15443	16.40	81.1	3.7	29.5	0.0	4946	17.37	77.8
-10	13606	16.90	83.1	4.3	0.0	2.1	5326	17.27	83.3
-11	16704	16.13	82.0	8.3	8.0	2.4	5010	16.77	85.0
-12	13348	14.97	82.4	8.7	2.1	4.9	5980	16.87	84.1
-13	16254	16.20	81.6	4.0	2.0	2.4	4978	18.30	83.6
-14	11498	16.30	79.2	6.7	8.9	2.2	2586	17.07	78.6
9936-# = RZM 8936⊗; = RZM R776-89-5H31									
9936 - 1	14148	16.27	81.7	9.0	49.0	0.0	5296	18.40	84.4
- 2	17960	16.43	82.3	2.7	21.2	3.3	6707	18.40	82.0
- 3	16381	15.27	87.6	3.0	16.3	2.2	4932	16.60	85.6
- 4	13536	15.97	81.6	0.7	0.0	2.4	3405	18.60	82.4

EVALUATION OF MULTIGERM S_n PROGENY LINES FROM F_2 POPNS DERIVED FROM F_1 HYBRIDS, SALINAS, CA., 2000

(TESTS 1600, 600, 5600)

(cont.)

Variety	Test 1600 (VY) Sugar Yield Lbs	Test 1600 (VY) Sucrose %	Test 1600 (VY) RJAP %	Test 1600 (VY) Powdery Mildew Score	Test 600 (NB) % Bolting 10/10	Test 600 (NB) %Downey Mildew 04/03	Test 5600 (RZM) Sugar Yield Lbs	Test 5600 (RZM) Sucrose %	Test 5600 (RZM) RJAP %
9936-# = RZM 8936⊗; = RZM R776-89-5H31 (cont.)									
9936 - 5	15895	15.63	81.5	1.7	8.6	23.4	5684	18.00	82.1
- 6	18191	16.73	83.5	0.3	0.0	4.8	3194	17.80	83.5
- 7	13962	16.23	81.6	3.0	0.0	0.0	2837	19.13	89.1
- 8	13546	15.17	82.9	1.0	7.8	1.8	4174	17.83	84.7
- 9	13401	16.17	81.6	2.3	38.0	22.4	3938	17.70	82.6
-10	13897	15.40	83.5	3.3	2.2	6.4	3194	17.40	81.1
-11	13203	17.20	79.8	7.3	2.1	9.8	3346	18.13	79.1
-12	17980	16.27	82.0	4.3	14.0	13.5	6691	17.30	80.5
-13	13768	16.63	80.3	1.0	24.5	4.8	3483	18.50	78.1
-14	16456	17.50	82.3	2.3	0.0	3.0	4304	18.20	82.5
-15	13217	17.00	81.0	4.0	2.0	7.0	2059	18.43	78.7
-16	17153	16.30	82.9	7.7	61.0	2.0	4762	18.20	83.6
9937-# = RZM 8937⊗; = RZM R776-89-5H11									
9937 - 1	15913	16.30	80.3	2.7	2.1	5.9	3789	17.67	80.1
- 2	14362	15.87	80.0	1.7	0.0	2.4	3234	17.77	79.1
- 3	16435	16.50	80.5	3.7	0.0	2.4	3892	16.67	79.3
- 4	15219	16.83	83.1	1.3	2.2	6.7	4593	17.60	78.6
9938-# = RZM 8938⊗; = RZM Z731H11									
9938 - 1	13975	16.03	84.6	1.0	0.0	2.1	4293	16.87	82.7
9939-# = RZM 8939⊗; = RZM Y769H31									
9939 - 1	13817	15.87	80.5	1.7	24.9	5.9	2620	17.53	79.0
- 2	15805	16.20	83.8	3.0	31.2	0.0	4738	16.20	81.1
- 3	13826	16.67	80.8	2.7	2.0	3.7	6026	18.63	82.3
- 4	16592	16.60	81.4	9.0	0.0	25.6	3186	17.80	81.2
- 5	14115	15.30	83.8	2.7	18.5	64.1	5550	17.57	86.4

EVALUATION OF MULTIGERM S_n PROGENY LINES FROM F_2 POPNS DERIVED FROM F_1 HYBRIDS, SALINAS, CA., 2000

(TESTS 1600, 600, 5600)

(cont.)

	Test 1600 (VY)				Test 600 (NB)		Test 5600 (RZM)		
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	% Bolting 10/10	%Downey Mildew 04/03	Sugar Yield Lbs	Sucrose %	RJAP %
9939-# = RZM 8939⊗; = RZM Y769H31 (cont.)									
9939 - 6	15732	15.53	86.5	3.0	58.3	30.8	2838	16.90	84.9
- 7	17536	16.57	81.6	2.7	87.2	2.1	6939	17.97	89.0
- 8	14739	16.80	81.5	5.0	42.1	15.3	3941	18.43	81.2
- 9	13748	16.70	83.9	2.3	15.3	11.6	3295	17.73	86.5
-10	15287	17.23	84.2	4.3	59.3	38.9	4861	17.90	81.6
-11	15851	16.47	83.6	1.7	4.4	0.0	5201	16.73	81.4
-12	17067	15.33	83.2	3.0	9.9	33.7	5112	18.13	83.9
-13	12388	15.47	82.7	1.7	41.0	2.6	2359	16.03	78.4
-14	16028	15.90	85.1	1.7	63.4	6.5	2197	15.60	77.5
-15	13443	15.67	84.6	4.0	97.9	13.2	2410	15.67	76.1
-16	16771	15.83	84.8	1.0	12.5	4.9	5391	17.07	85.8
-17	16668	16.30	81.6	2.7	39.2	3.0	5099	16.80	87.1
-18	17102	16.80	82.1	2.3	68.0	12.2	4723	17.20	86.5
-19	12473	17.17	78.8	2.0	0.0	2.2	4334	17.70	81.5
-20	13497	15.83	80.8	8.7	2.4	6.8	2292	17.53	80.7
-21	13497	17.03	80.2	4.3	33.9	5.6	3872	16.40	75.5
-22	14334	15.83	82.1	0.0	29.0	0.0	2084	17.37	83.0
-23	13662	15.90	82.1	3.7	7.1	33.8	5649	18.67	86.9
-24	14607	17.23	81.4	3.0	0.0	7.9	2775	18.17	84.4
-25	13563	16.20	78.5	2.0	10.3	9.9	4291	18.03	80.4
Mean	14941.3	16.25	82.1	3.7	20.2	8.1	4635.8	17.52	82.6
LSD (.05)	3442.1	1.12	3.8	2.3	16.8	17.8	3532.3	1.77	7.8
C.V. (%)	14.3	4.26	2.9	38.9	51.5	136.5	47.2	6.24	5.8
F value	1.6*	2.17**	1.7**	8.2**	17.6**	3.3**	2.0**	1.72*	1.2NS

EVAL OF MULTIGERM SELF-FERTILE, Aa, S_n PROGENY LINES FROM RANDOM-MATED POPULATIONS WITH RESISTANCE FROM *Bvm*, SALINAS, CA., 1999-2000

(TESTS 1700, 700, 5700, B900, B1300)

	Test 1700				Test 700		Test 5700		
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	Powdery Mildew Score	% Bolting 10/10	%Downey Mildew 04/03	Sugar Yield Lbs	Sucrose %	RJAP %
9926-# = RZM 8926(Iso)⊗									
9926 - 1	17666	17.63	81.0	6.0	9.8	7.8	7629	17.30	82.5
- 2	14416	15.93	79.3	1.7	13.8	1.9	6733	16.93	82.5
- 3	14202	16.53	81.6	7.7	69.2	9.5	5536	17.20	84.2
- 4	14565	16.20	78.6	6.0	64.3	0.0	5164	17.17	82.8
- 5	17870	17.03	80.4	4.7	6.1	18.4	6179	17.07	81.7
- 6	17030	15.43	82.5	1.7	30.2	5.3	8345	17.13	85.6
- 7	17865	17.67	83.5	7.7	42.2	4.6	4489	18.10	82.9
- 8	15214	16.17	82.1	3.0	0.0	5.6	5290	17.77	82.5
- 9	13124	16.73	80.5	1.7	0.0	0.0	3737	17.03	78.9
-10	16452	15.83	82.0	9.0	4.9	4.5	4992	16.70	79.6
-11	14607	16.77	81.8	2.3	53.6	5.6	5989	17.77	82.8
-12	13855	16.63	82.5	1.0	1.9	2.1	5091	16.20	84.2
-13	16317	16.33	81.5	4.3	11.3	1.9	5599	16.07	78.3
-14	16213	17.93	81.3	6.3	2.6	12.1	3863	17.30	83.8
-15	17134	16.97	81.7	4.7	17.9	10.3	4323	17.57	81.3
-16	13989	16.93	74.7	4.0	1.9	21.4	4054	18.37	83.1
9934-# = RZM 7934⊗; = RZM 6913-70aa x R636									
9934 - 1	17464	16.23	79.5	9.0	2.1	2.2	7109	17.13	79.2
- 2	15949	16.60	80.0	7.0	3.8	7.6	7093	15.73	83.3
- 3	18319	16.00	84.2	8.7	9.9	2.1	3184	16.50	85.8
- 4	15467	16.10	80.1	9.0	52.7	10.8	12095	16.67	82.4

EVAL OF MULTIGERM SELF-FERTILE, Aa, S_n PROGENY LINES FROM RANDOM-MATED POPULATIONS WITH RESISTANCE FROM *Bvm*, SALINAS, CA., 1999-2000

(TESTS 1700, 700, 5700, B900, B1300)

	Test 1700				Test 700		Test 5700		
Variety	Sugar Yield	Sucrose	RJAP	Powdery Mildew	% Bolting	%Downey Mildew	Sugar Yield	Sucrose	RJAP
	Lbs	%	%	Score	10/10	04/03	Lbs	%	%
9934-# = RZM 7934⊗; = RZM 6913-70aa x R636 (cont.)									
9934 - 5	15525	16.70	79.3	9.0	48.1	5.8	8031	16.57	80.2
- 6	17976	16.20	83.5	9.0	6.7	19.0	8270	16.13	83.0
- 7	16011	16.83	81.7	8.7	2.0	5.7	5490	17.27	81.2
- 8	17359	16.63	81.3	9.0	7.7	35.0	6091	16.93	84.1
- 9	14592	16.97	80.2	7.7	39.1	10.3	5968	16.57	80.0
-10	16872	15.97	80.9	9.0	2.1	30.1	4488	14.93	85.7
-11	15140	16.53	79.5	8.0	1.9	22.8	5828	17.00	82.6
-12	15336	17.13	81.1	7.3	47.2	1.9	6431	17.07	82.0
-13	17887	15.73	81.9	9.0	0.0	6.0	5968	16.57	84.2
-14	17014	15.87	82.2	9.0	12.7	0.0	4488	14.93	82.2
-15	17883	16.47	78.9	8.3	15.5	0.0	5828	17.00	81.7
-16	16678	16.77	81.7	6.0	0.0	4.8	6431	17.07	83.8
Mean	16124.7	16.55	81.0	6.4	18.2	8.6	6168.3	16.93	82.4
LSD (.05)	2473.0	0.79	3.0	2.6	18.9	17.6	3427.9	1.04	5.1
C.V. (%)	9.4	2.93	2.2	24.4	63.6	125.3	34.1	3.77	3.8
F value	2.8**	4.25**	2.9**	8.9**	10.3**	2.0*	2.6**	3.34**	1.1NS

EVAL OF MULTIGERM SELF-FERTILE, Aa, S_n PROGENY LINES FROM RANDOM-MATED POPULATIONS WITH RESISTANCE FROM *Bvm*, SALINAS, CA., 1999-2000

(TESTS 1700, 700, 5700, B900, B1300)

	Test B900					Test B1300	
Variety	Sugar Yield Lbs	Sucrose %	Bolting %	Root Rot %	Appearance Score 5/17	Segregation Pattern range	Appearance Score 5/18
9926-# = RZM 8926(Iso)⊗							
9926 - 1	4813	16.17	0.0	4.3	4.5	5	5.0
- 2	6933	14.36	0.0	7.0	4.0	5	5.0
- 3	6572	15.91	0.0	3.7	3.0	5	5.0
- 4	3325	15.87	0.0	1.7	4.0	5	5.0
- 5	4249	15.30	0.0	10.3	3.5	5	5.0
- 6	4316	13.41	0.0	23.9	4.5	4	5.0
- 7	9102	15.49	0.0	2.1	3.5	4	4.0
- 8	4344	14.41	0.0	7.1	3.5	3	3.0
- 9	1535	14.28	0.0	3.6	4.5	5	5.0
-10	5119	14.33	0.0	11.5	3.5	4	5.0
-11	5939	15.81	0.0	3.4	3.0	1	1.0
-12	2211	14.28	0.0	6.9	4.0	5	5.0
-13	8633	15.79	0.0	0.0	3.0	4	5.0
-14	1497	15.61	0.0	3.8	4.5	4	4.0
-15	7285	15.77	0.0	0.0	3.0	3	3.0
-16	2148	16.15	0.0	1.8	4.0	4	4.0
9934-# = RZM 7934⊗; = RZM 6913-70aa x R636							
9934 - 1	6208	14.23	3.4	1.7	2.0	2	2.0
- 2	7489	16.33	0.0	0.0	3.0	3	3.0
- 3	9679	15.21	0.0	0.0	2.0	1	1.0
- 4	2239	15.17	38.2	16.0	4.5	5	5.0

EVAL OF MULTIGERM SELF-FERTILE, Aa, S_n PROGENY LINES FROM RANDOM-MATED POPULATIONS WITH RESISTANCE FROM *Bvm*, SALINAS, CA., 1999-2000

(TESTS 1700, 700, 5700, B900, B1300)

	Test B900					Test B1300	
Variety	Sugar Yield	Sucrose	Bolting	Root Rot	Appearance Score	Segregation Pattern	Appearance Score
	Lbs	%	%	%	5/17	range	5/18
9934-# = RZM 7934⊗; = RZM 6913-70aa x R636 (cont.)							
9934 - 5	5478	15.15	12.6	0.0	1.5	2	2.0
- 6	8547	14.79	0.0	0.0	3.0	3 - 4	3.0
- 7	4527	14.86	0.0	1.9	3.5	5	5.0
- 8	6155	14.22	0.0	0.0	2.0	2 - 4	2.0
- 9	5105	15.25	19.3	0.0	2.0	2 - 4	2.0
-10	7722	14.40	0.0	1.9	2.0	2 - 4	2.0
-11	2625	14.83	0.0	5.5	4.0	5	5.0
-12	7265	14.82	11.6	0.0	2.5	2	1.0
-13	4309	14.35	0.0	11.1	3.5	4	5.0
-14	5619	13.05	1.7	3.8	3.0	2 - 3	2.0
-15						5	5.0
-16						4	4.0

EVALUATION OF MULTIGERM S_1 PROGENY LINES FROM RANDOM-MATED POPULATIONS, SALINAS, CA., 2000

(TESTS 1800, 800, 5800)

	Test 1800 (VY)				Test 800 (NB)		Test 5800 (RZM)		
Variety	Sugar Yield	Sucrose	RJAP	Powdery Mildew	% Bolting	%Downey Mildew	Sugar Yield	Sucrose	RJAP
	Lbs	%	%	Score	10/10	04/03	Lbs	%	%
Checks									
97-US22/3	16503	17.17	82.8	8.3	90.3	5.8			
99-C37	14773	16.80	82.1	9.0	3.9	2.4			
9931	19348	16.67	83.5	4.3			8151	15.60	84.5
Z925	18504	17.87	85.4	6.0			8413	16.87	83.9
US H11							5156	14.20	86.5
B4776R							11982	16.40	86.2
8918-12					10.5	2.2			
8913-70					0.0	16.2			
9931-# = RZM 8931⊗									
9931 - 1	16838	16.77	85.0	7.3	0.0	0.0	6754	16.43	85.6
- 2	14321	15.47	80.7	4.3	41.2	9.9	8120	16.87	85.4
- 3	17152	16.60	83.4	1.7	0.0	0.0	7409	16.03	83.4
- 4	14043	16.13	81.5	1.0	0.0	0.0	6688	15.97	82.9
- 5	14337	17.10	80.8	5.0	0.0	9.1	7241	16.67	80.9
- 6	17013	16.27	83.9	9.0	0.0	18.9	6486	15.10	82.5
- 7	14756	16.17	81.0	4.3	66.6	0.0	5737	15.93	79.9
- 8	16141	16.07	81.6	7.3	11.5	14.1	7138	16.80	86.5
- 9	15824	16.27	77.9	7.0	4.1	0.0	9196	17.17	86.0
-10	12876	16.60	82.2	3.0	8.4	33.2	4086	15.30	84.0
-11	13690	16.47	81.1	3.3	14.4	32.9	5883	17.17	82.7
-12	17053	16.07	79.9	9.0	4.4	2.4	6984	15.53	81.8
-13	17363	15.97	80.7	3.0	22.0	13.4	5612	16.93	83.5
-14	15301	15.37	82.7	3.3	15.0	26.9	6914	15.37	84.6
-15	15854	15.47	79.7	8.0	12.8	10.8	3460	14.50	83.2
-16	17837	15.70	84.1	1.7	12.8	14.7	5583	15.10	83.8

EVALUATION OF MULTIGERM S_1 PROGENY LINES FROM RANDOM-MATED POPULATIONS, SALINAS, CA., 2000

(TESTS 1800, 800, 5800)

Variety	Test 1800 (VY)				Test 800 (NB)		Test 5800 (RZM)		
	Sugar Yield	Sucrose	RJAP	Powdery Mildew	% Bolting	%Downey Mildew	Sugar Yield	Sucrose	RJAP
	Lbs	%	%	Score	10/10	04/03	Lbs	%	%
9931-# = RZM 8931⊗ (cont.)									
9931 -17	14168	17.80	86.1	2.7	46.7	14.6	4519	17.70	84.0
-18	18808	16.40	85.6	1.7	2.2	25.4	5731	16.80	84.4
-19	17395	16.07	82.8	3.3	98.2	4.5	8020	14.60	83.8
-20	19047	15.80	83.7	1.7	0.0	7.7	7196	16.30	88.8
-21	14293	15.17	81.7	7.0	32.2	7.1	5213	14.60	82.0
-22	15186	17.07	80.3	7.0	2.1	2.1	4692	15.90	80.8
-23	19079	16.30	82.9	4.7	9.3	6.7	5151	15.43	79.9
-24	13883	15.07	82.4	4.3	42.4	7.6	4955	14.33	84.1
-25	14684	16.47	81.7	4.3	0.0	7.9	1594	14.60	79.9
-26	15370	15.43	84.7	4.7	2.4	2.4	4817	15.63	82.3
-27	14273	16.00	84.5	3.7	13.4	2.0	4790	16.43	81.6
-28	16300	16.23	82.8	7.0	0.0	2.4	5292	16.27	85.6
-29	17046	15.97	80.9	5.0	0.0	3.0	4145	16.23	80.5
-30	19602	16.00	83.9	4.7	4.6	4.6	3585	15.43	80.4
-31	16428	15.63	81.0	2.7	21.2	0.0	6726	16.77	84.1
-32	15944	16.60	82.0	5.3	27.9	0.0	5529	16.80	81.6
9931-# = RZM 8931⊗									
9931 -33	13173	15.77	82.3	3.0	6.5	4.5	2496	16.13	76.1
-34	16506	15.60	79.6	2.7	100.0	2.4	3447	16.37	80.9
-35	14873	14.20	81.9	2.0	0.0	7.9	6192	16.77	85.8
-36	16468	15.03	81.1	8.0	5.6	4.9	3110	15.10	76.7
-37	13937	14.83	84.1	6.3	12.1	5.6	5528	15.07	84.0
-38	13725	16.10	82.3	5.0	2.6	9.2	3299	16.17	80.3
-39	13103	14.60	83.4	6.7	0.0	0.0	3895	15.07	82.7
-40	17211	16.17	82.5	2.7	2.8	10.4	4823	16.13	82.5

EVALUATION OF MULTIGERM S_1 PROGENY LINES FROM RANDOM-MATED POPULATIONS, SALINAS, CA., 2000

(TESTS 1800, 800, 5800)

Variety	Test 1800 (VY) Sugar Yield	Sucrose	RJAP	Powdery Mildew	Test 800 (NB) % Bolting	%Downey Mildew	Test 5800 (RZM) Sugar Yield	Sucrose	RJAP
	Lbs	%	%	Score	10/10	04/03	Lbs	%	%
9931-# = RZM 8931⊗ (cont.)									
9931 -41	16133	16.27	83.7	2.0	6.5	0.0	6219	17.73	83.0
-42	13802	15.17	81.5	2.3	0.0	17.7	5590	15.27	80.4
-43	13411	15.63	80.2	1.0	2.6	5.1	3428	15.47	77.5
-44	17116	17.57	80.5	8.3	2.2	0.0	5231	17.00	81.3
-45	16745	16.67	81.6	2.0	2.2	2.2	6416	17.07	83.7
-46	18600	17.23	83.1	7.0	95.6	0.0	5413	16.37	82.2
-47	15856	16.67	82.0	7.7	23.4	2.6	5107	16.97	81.8
-48	17329	16.17	84.4	6.7	28.2	12.6	5514	16.07	83.8
-49	14118	15.43	83.0	1.3	0.0	25.5	3440	14.97	77.3
-50	15166	14.83	84.0	3.0	27.3	12.3	4892	16.10	80.0
-51	14238	15.93	81.6	2.3	30.1	10.1	4636	16.73	81.5
-52	14945	14.73	81.7	5.0	0.0	7.4	4480	16.07	81.6
-53	14044	15.73	82.2	2.3	0.0	0.0	7003	16.90	81.9
-54	17141	16.80	82.6	3.7	0.0	12.4	5349	16.27	80.9
-55	18160	16.57	81.8	4.3	76.6	5.0	5198	17.47	81.0
-56	19781	17.20	84.7	3.0	0.0	5.1	5606	16.47	85.4
-57	12354	15.87	80.8	2.3	5.6	2.6	3691	16.03	77.7
-58	16158	15.03	82.3	7.7	0.0	0.0	4145	15.87	82.9
-59	14530	14.97	79.1	5.0	9.9	10.5	1907	15.67	79.1
-60	16020	16.80	81.8	1.7	0.0	20.2	2592	15.93	77.0
-61	14774	16.10	80.9	1.7	60.3	50.2	4902	16.33	80.5
-62	17889	15.10	83.3	8.0	16.2	3.5	6166	15.37	82.3
9931 -201	16938	16.87	84.7	2.3	0.0	14.7	8115	16.47	83.3
-202	15525	16.63	83.9	1.3	2.1	4.2	6250	16.57	83.1

EVALUATION OF MULTIGERM S_1 PROGENY LINES FROM RANDOM-MATED POPULATIONS, SALINAS, CA., 2000

(TESTS 1800, 800, 5800)

Variety	Test 1800 (VY)				Test 800 (NB)		Test 5800 (RZM)		
	Sugar Yield	Sucrose	RJAP	Powdery Mildew	% Bolting	%Downey Mildew	Sugar Yield	Sucrose	RJAP
	Lbs	%	%	Score	10/10	04/03	Lbs	%	%
9931-# = RZM 8931⊗ (cont.)									
9931 -203	15951	14.80	83.8	2.0	0.0	13.2	6665	21.50	83.9
-204	16367	14.80	80.4	4.7	7.8	6.7	4424	15.66	80.2
-205	14321	16.43	79.0	2.7	0.0	20.6	4512	13.60	79.1
-206	16915	16.30	79.1	4.3	91.0	28.5	3122	9.68	71.2
-207	15961	15.53	80.4	5.0	15.8	18.9	3201	11.22	80.2
-208	16144	15.70	86.0	3.0	40.0	23.3	3854	12.07	84.1
-209	15080	16.03	81.4	9.0	0.0	10.8	5571	17.58	81.7
-210	15370	16.80	82.6	3.3	2.4	40.8	3699	12.28	80.3
9931 -211	16123	16.63	82.5	5.3	34.5	28.9	4413	13.69	87.9
-212	16590	16.73	84.5	5.0	9.3	33.6	3418	10.89	75.6
-213	14495	15.30	83.6	1.3	0.0	51.1	3928	12.15	81.6
-214	17061	15.23	84.3	5.0	17.8	39.4	4109	12.98	84.9
-215	16354	16.33	82.5	4.3	2.6	28.4	6145	18.14	83.4
-216	18077	16.30	85.4	7.7	0.0	51.0	5319	15.70	82.4
-217	14126	15.00	83.3	7.7	0.0	16.7	4037	12.63	82.7
-218	19565	16.70	83.7	6.3	38.5	41.0	5898	17.22	84.5
-219	15569	15.63	82.5	1.0	0.0	10.5	3953	12.26	80.5
-220	15790	15.30	80.7	1.3	5.3	0.0	4931	15.87	79.6
-221	19510	17.37	85.9	5.0	73.8	26.4	3723	11.33	79.3
-222	18038	17.37	80.8	6.3	0.0	18.5	5685	16.55	80.9
-223	17677	16.20	83.4	2.0	17.2	0.0	3418	10.74	82.2
-224	12034	14.47	81.9	2.3	2.4	13.4	3751	11.39	80.4
-225	18534	16.67	82.1	2.0	0.0	7.1	6670	20.37	84.0
-226	16404	15.80	82.4	3.0	21.7	18.9	5559	17.49	84.5

EVALUATION OF MULTIGERM S_1 PROGENY LINES FROM RANDOM-MATED POPULATIONS, SALINAS, CA., 2000

(TESTS 1800, 800, 5800)

	Test 1800 (VY)				Test 800 (NB)		Test 5800 (RZM)		
Variety	Sugar Yield	Sucrose	RJAP	Powdery Mildew	% Bolting	%Downey Mildew	Sugar Yield	Sucrose	RJAP
	Lbs	%	%	Score	10/10	04/03	Lbs	%	%
9931-# = RZM 8931⊗	(cont.)								
9931 -227	15923	16.77	84.8	9.0	48.7	32.6	5090	16.30	81.6
-228	18361	16.27	82.8	1.3	0.0	13.2	5916	17.13	83.4
Z931-# = RZM Z831⊗									
Z931 - 1	15380	17.30	81.4	9.0	6.6	11.9	3371	17.17	85.0
- 2	16654	16.67	84.8	7.7	41.4	13.1	6704	16.43	83.4
- 3	15457	15.30	83.0	7.7	24.9	57.6	4504	17.70	85.0
- 4	17510	16.77	81.2	8.0	60.0	13.8	4845	17.13	81.1
- 5	15412	15.53	84.2	6.7	2.0	17.7	8296	16.60	85.6
- 6	15037	14.90	81.6	6.0	0.0	76.0	5538	16.73	82.2
- 7	14276	15.00	85.7	7.3	39.2	67.5	6278	15.13	83.9
- 8	17079	16.63	82.8	3.7	4.1	57.7	6177	16.50	81.4
- 9	13694	15.23	82.8	6.3	10.5	26.5	3791	15.80	85.9
-10	14802	15.80	82.5	4.0	53.4	42.6	4920	17.30	84.0
-11	14997	17.33	82.4	6.7	53.9	52.2	6349	17.97	82.3
-12	15351	15.63	83.5	5.3	80.1	0.0	4772	16.37	83.1
-13	15988	16.33	81.5	7.7	16.6	75.2	4623	16.87	80.6
-14	15508	17.40	83.3	2.7	0.0	36.6	7614	17.33	80.2
-15	15880	16.40	80.0	3.7	46.0	15.8	6066	16.67	82.1
-16	15094	16.17	83.2	5.3	48.7	7.0	4138	16.60	83.1
-17	15910	16.67	82.6	2.0	4.8	25.3	5725	16.63	85.2
-18	19190	17.20	82.8	3.0	0.0	13.9	6233	16.50	83.3
-19	15123	16.97	82.2	4.3	31.1	15.8	6258	17.20	84.5
-20	15969	17.87	82.6	1.7	61.1	5.6	7050	17.93	84.1

EVALUATION OF MULTIGERM S_1 PROGENY LINES FROM RANDOM-MATED POPULATIONS, SALINAS, CA., 2000

(TESTS 1800, 800, 5800)

	Test 1800 (VY)				Test 800 (NB)		Test 5800 (RZM)		
Variety	Sugar Yield	Sucrose	RJAP	Powdery Mildew	% Bolting	%Downey Mildew	Sugar Yield	Sucrose	RJAP
	Lbs	%	%	Score	10/10	04/03	Lbs	%	%
Z931-# = RZM Z831⊗ (cont.)									
Z931 -21	15913	17.03	81.2	5.7	53.5	22.6	4858	16.27	82.0
-22	15382	14.23	86.1	6.7	2.8	33.7	6465	15.07	85.7
-23	15185	16.50	80.9	3.7	0.0	28.4	5618	17.07	80.7
-24	18635	16.77	85.4	5.7	28.4	27.8	5274	17.43	83.5
-25	15304	17.37	83.6	6.3	12.8	59.0	4248	17.20	80.3
-26	16990	16.40	83.7	6.7	2.8	13.8	3923	17.23	80.9
-27	16723	15.83	85.0	4.0	31.1	39.5	8233	17.33	84.8
-28	18803	17.00	82.6	8.7	31.8	3.0	6141	16.20	84.5
-29	12927	15.23	80.6	6.0	33.4	15.1	6094	16.00	84.2
-30	17310	16.33	85.3	3.3	67.7	0.0	3036	15.33	87.2
-31	14311	16.93	82.9	7.3	18.4	2.6	4599	17.30	83.6
-32	15455	16.77	81.3	7.0	0.0	5.4	6956	17.20	83.0
-33	13422	17.23	80.2	4.7	12.3	0.0	4502	17.63	83.1
-34	12281	14.93	81.0	6.0	38.4	19.7	6075	15.63	86.5
Mean	15938.2	16.14	82.5	4.7	19.4	16.2	5338.3	16.22	82.5
LSD (.05)	3193.9	1.15	3.0	2.7	15.6	24.1	2821.7	1.28	5.1
C.V. (%)	12.5	4.42	2.3	36.1	50.1	92.6	32.9	4.90	3.9
F value	2.3**	3.93**	2.4**	5.5**	20.2**	3.8**	2.4**	3.45**	2.0**

EVALUATION OF S_1 POLLINATORS (PROGENY LINES), SALINAS, CA., 2000

(Tests 2100, 200, 4400, 6300)

Variety	Test 2100 Sugar Yield lbs	Test 2100 Sucrose %	Test 2100 RJAP %	Test 2100 Powdery Mildew score	Test 200 % Bolting 10/10	Test 200 Downey Mildew %	Test 4400 ERR (%R)	Test 6300 Sugar Yield (Lbs)	Test 6300 Sucrose %
Checks									
97-SP22-0	14794	15.47	85.1	5.5	90.6	0.0			
R776-89-5NB	14621	16.95	81.6	3.5					
9924	17849	16.68	83.5	4.8	17.8	0.0			
9931R	19149	16.12	82.1	4.6					
Progeny Lines									
9924 - 2	15041	17.23	82.1	2.8	9.7	21.1	86.3	7325	18.00
9924 - 6	16275	16.63	83.8	4.4	3.3	1.1	66.4	5739	16.70
9924 -10	16361	16.88	84.0	5.3	63.8	1.4	82.2	10575	17.43
9924 -74	16051	17.43	84.7	6.0	7.9	0.0	79.8	6743	17.23
9924 -77	18825	17.43	82.9	3.9	53.9	0.0	78.6	10110	18.47
9924 -78	16110	18.28	81.6	5.8	3.6	0.0	79.9	5367	16.57
9924 -114	16364	17.17	82.1	4.6	71.0	9.8	88.4	6630	18.57
9931 -18	15256	16.80	81.5	2.5	28.5	4.9	78.8	6759	18.00
9931 -24	14364	16.82	80.5	4.3	0.0	0.0	80.5	5424	18.17
9931 -29	15399	16.68	81.8	4.8	84.4	6.5	74.0	5904	17.17
9929 - 4	14049	16.05	80.3	2.9	4.3	0.0	74.3	6296	18.37
9929 - 9	14382	16.18	81.1	3.5	45.5	0.0	73.3	9238	17.17
9929 -45	15215	16.13	82.8	5.1	14.1	6.8	71.3	6333	17.97
9929 -47	13731	16.10	80.1	5.9	9.2	1.2	83.8	3374	17.80
9929 -48	14100	17.38	82.2	3.9	0.0	1.2	59.6	3304	17.67
9929 -56	11304	16.18	83.8	4.1	0.0	1.4	84.1	4070	18.10
9929 -62	16189	15.55	82.4	2.8	0.0	3.6	69.9	5054	17.47
9930 -17	13897	16.48	84.4	4.2	0.0	1.2	80.9	5476	17.13
9930 -32	13856	16.57	80.6	2.8	34.2	1.5	58.5	1756	16.90
9930 -35	14365	17.38	82.6	6.2	26.3	2.7	48.3	6131	18.23

EVALUATION OF S_1 POLLINATORS (PROGENY LINES), SALINAS, CA., 2000

(Tests 2100, 200, 4400, 6300)

	Test 2100				Test 200		Test 4400	Test 6300	
Variety	Sugar Yield	Sucrose	RJAP	Powdery Mildew	% Bolting	Downey Mildew	ERR	Sugar Yield	Sucrose
	lbs	%	%	score	10/10	%	(%R)	(Lbs)	%
Progeny Lines (cont.)									
9927 - 4	17266	16.03	83.1	7.0	11.1	1.3	68.3	9633	16.20
9927 -17	16249	15.55	83.2	4.5	0.0	10.8	84.8	6102	16.33
9928 -34	16565	16.07	82.5	5.2	9.1	2.2	78.1	6932	16.97
9928 -107	16658	16.30	80.6	4.5	26.5	2.7	90.8	7979	17.27
Retest of Progeny Lines									
R976 -89-18	15196	15.55	82.3	4.3	18.8	1.2		7115	17.13
8913 -70	15603	16.33	82.0	4.7	2.1	5.4	88.2		
8918 -12	16462	16.10	81.9	2.1	8.2	2.2	86.5		
9719Bm	14550	16.25	85.7	6.6	1.0	2.0			
Mean	15503.0	16.52	82.5	4.5	23.7	1.6	70.7	6615.2	17.46
LSD (.05)	2219.1	0.86	2.7	1.1	14.2	5.7	18.8	2248.0	0.97
C.V. (%)	12.6	4.55	2.9	21.3	37.3	217.4	16.4	20.8	3.41
F value	3.9**	4.59**	2.1**	9.8**	17.3**	2.0**	7.4**	8.1**	4.99**

PERFORMANCE OF HYBRIDS WITH S_1 PROGENY POLLINATORS, SALINAS, CA, 2000

(TESTS 3000, 100, 6900, B300, B600)

	Test 3000			Test 100		Test 6900			Test B300			Test B600		
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	% Bolt. 10/10	%Downey Mildew 04/03	Sugar Yield Lbs	Sucrose %	RJAP %	Sugar Yield Lbs	Sucrose %	Bolt. %	Sugar Yield Lbs	Sucrose %	Bolt. %
3000-1: Checks and retests from 1999														
Alpine	18915	16.99	83.5	32.3	0.0	8708	15.48	83.6	11895	15.35	1.6	11134	15.69	0.9
Beta 4430R	20767	17.38	84.7	41.5	0.0	9775	16.35	83.4	12349	15.62	0.0			
9918-21H50	18874	16.33	84.9	6.1	0.0	9457	15.14	83.7				11448	16.25	0.0
8925-19H50	18560	16.29	83.1			10005	15.09	83.9						
Z825-6H50	19539	17.60	83.7			9605	15.84	84.0						
Z825-9H50	17690	17.73	82.8			9587	16.76	82.5						
8929-112H50	18974	17.33	83.8			10073	16.23	83.5						
8929-114H50	18710	16.90	83.6			10288	15.52	82.5	11757	16.03	1.8			
8929-115H50	17702	17.21	83.3			8250	15.56	83.5						
8930-19H50	18848	16.88	84.4			10287	15.81	83.3				11382	17.12	0.0
8927-29H50	17229	17.14	82.6			8757	16.49	82.4						
8911-4-10H50	17742	17.48	82.2			10300	15.79	81.2						
9941H50	18038	16.84	83.8			9313	15.41	84.7						
9941H6	17870	17.13	82.2	10.3	0.0	9419	15.82	82.5						
R976-89H5	17732	17.30	82.9	9.9	0.0	10480	16.67	83.8						
R976-89H6	18591	17.13	83.4	5.0	0.0	5357	13.77	84.1						
3000-2: Hybrids with popns-931 & -924, et al.														
Beta 4776R	19118	17.45	84.9	21.7	0.0	10210	15.69	84.1	10130	16.40	0.3	9625	16.73	1.0
9931H50	17637	16.51	83.2	13.4	0.0	8547	15.07	83.6	11425	15.01	3.0	10687	15.98	1.3
Z925H50	18058	17.10	84.1	35.2	0.0	9348	15.38	82.2				11888	16.54	9.5
9931-18H50	17686	16.96	82.3	29.5	0.0	8532	15.60	83.6	12017	15.89	11.8	10827	17.24	9.6
9931-24H50	17351	17.09	82.1	4.8	0.0	9599	16.10	82.0	10749	15.74	1.8	10614	16.88	0.4
9931-29H50	18726	16.54	83.2	44.7	0.0	8790	14.96	83.4	12415	15.64	5.8	11676	16.44	0.5
9924H50	18162	16.84	83.3	23.0	0.0	8862	15.26	83.6				11536	16.48	1.4
9924-2H50	18232	17.71	83.6	7.7	0.0	8843	15.61	83.2	11267	15.88	0.3	10391	16.66	0.0

PERFORMANCE OF HYBRIDS WITH S_1 PROGENY POLLINATORS, SALINAS, CA, 2000

(TESTS 3000, 100, 6900, B300, B600)

(cont.)

Variety	Test 3000 Sugar Yield Lbs	Test 3000 Sucrose %	Test 3000 RJAP %	Test 100 % Bolt. 10/10	Test 100 %Downey Mildew 04/03	Test 6900 Sugar Yield Lbs	Test 6900 Sucrose %	Test 6900 RJAP %	Test B300 Sugar Yield Lbs	Test B300 Sucrose %	Test B300 Bolt. %	Test B600 Sugar Yield Lbs	Test B600 Sucrose %	Test B600 Bolt. %
3000-2: Hybrids with popns-931 & -924, et al. (cont.)														
9924-6H50	17334	17.29	82.4	6.8	0.0	8447	15.44	82.1	11638	16.23	0.0	10619	17.21	0.0
9924-10H50	17276	16.96	83.1	33.8	0.0	8989	15.60	84.5	11304	15.02	7.0	10997	16.25	7.7
9924-74H50	18061	16.99	84.2	13.0	0.0	8719	15.39	83.3	10798	15.80	15.9	10502	16.19	3.3
9931H5	18280	17.11	83.3	9.2	1.2	10544	15.94	81.7						
9924-78H50	18347	17.42	83.6	5.7	0.0	8760	15.65	81.8	10470	15.96	1.5	10502	16.19	3.3
9924-114H50	16753	16.91	82.6	54.3	0.0	7947	15.95	82.1	11027	16.11	9.5	9814	17.08	5.6
9926H50	18523	16.79	82.8	13.9	1.3	9328	15.11	82.8				9915	16.13	2.7
9927-4H50	19265	16.71	84.2	14.3	0.0	11233	15.30	82.9	12973	16.02	2.5	11890	16.55	0.5
3000-3: Hybrids with popns-929 & -930, et al.														
9927-17H50	19358	16.59	83.9	7.6	1.2	9570	14.93	84.3	11985	15.49	12.6	10810	15.97	5.2
9928-34H50	18496	16.33	83.9	13.9	0.0	10190	15.01	82.9	12216	14.78	0.8	11621	16.30	0.0
9928-107H50	17826	17.00	83.9	13.7	1.4	8448	15.05	82.3	11281	15.55	1.4	11069	16.50	0.0
R976-89-18H50	18558	16.80	83.6	14.9	0.0	7824	15.02	83.8				12221	16.38	1.3
9929-4H50	19147	17.00	83.3	10.4	2.1	8489	15.89	82.1	12751	15.99	2.3	11249	16.69	1.3
9929-9H50	18764	16.94	83.7	42.9	0.0	9822	15.85	83.3	12048	15.51	7.9	11807	17.08	6.8
9939-45H50	18876	17.01	84.5	14.2	1.1	8578	15.68	84.0	11271	16.12	4.2			
9929-47H50	18162	16.88	84.2	12.2	0.0	7943	15.50	84.3	12180	15.79	7.1	11075	16.19	2.3
9929-48H50	18060	17.50	83.5	0.0	0.0	6373	14.65	83.6	10814	14.90	0.0	10862	15.78	0.0
9929-56H50	16723	16.98	83.4	0.0	0.0	6684	15.31	84.9	10465	15.82	0.0	9956	16.65	0.0
9929-62H50	19059	16.49	83.1	1.2	0.0	9301	15.39	83.3	13564	15.24	0.9	13761	16.68	0.0
R978H50	17836	17.20	83.6	18.5	1.4	9410	15.71	83.0						

PERFORMANCE OF HYBRIDS WITH S_1 PROGENY POLLINATORS, SALINAS, CA, 2000

(TESTS 3000, 100, 6900, B300, B600)

(cont.)

	Test 3000			Test 100		Test 6900			Test B300			Test B600		
Variety	Sugar Yield Lbs	Sucrose %	RJAP %	% Bolt. 10/10	%Downey Mildew 04/03	Sugar Yield Lbs	Sucrose %	RJAP %	Sugar Yield Lbs	Sucrose %	Bolt. %	Sugar Yield Lbs	Sucrose %	Bolt. %
3000-3: Hybrids with popns-929 & -930, et al. (cont.)														
9930-17H50	17455	16.88	83.0	1.4	0.0	7095	14.76	84.3	11478	15.84	1.1	11019	16.70	0.0
9930-32H50	18738	17.58	82.7	44.8	1.2	6098	14.93	82.8	11080	15.25	4.5	10062	15.60	0.5
9930-35H50	18037	17.42	84.0	18.5	0.0	9447	16.36	82.1	12497	16.79	0.6	11197	17.92	0.0
Phoenix	18126	17.06	85.0	31.4	0.0	7247	16.39	83.5	11225	15.65	2.4	11496	16.94	0.0
Mean	18287.7	17.03	83.5	23.4	0.4	8935.1	15.55	83.2	11625.1	15.68	3.8	10948.5	16.45	2.6
LSD (.05)	1180.0	0.48	1.3	15.0	2.2	1106.1	0.57	2.0	1109.3	0.67	3.9	1203.4	0.72	3.4
C.V. (%)	6.6	2.83	1.6	39.7	363.4	12.6	3.70	2.4	9.7	4.31	104.6	11.2	4.46	133.4
F value	3.2**	4.31**	2.3**	9.4**	0.9NS	9.4**	7.65**	1.5*	3.8**	3.49**	8.7**	3.5**	4.03**	9.4**

RETEST OF HYBRIDS FROM 1999 WITH MONOGERM S_1 PROGENY LINES, 2000

(Tests 3200 and 7100)

Variety	Test 3200 (Yield) Sugar Yield Lbs	Test 3200 (Yield) Sucrose %	Test 3200 (Yield) RJAP %	Test 7100 (RZM) Sugar Yield Lbs	Test 7100 (RZM) Sucrose %	Test 7100 (RZM) RJAP %
Checks						
Beta 4776R	17827	17.30	84.0	9744	15.67	83.3
Alpine	18250	16.70	82.5	8098	15.63	82.3
Y969H5	18162	16.97	82.1	9677	15.87	82.5
Y969H46	17759	16.42	81.9	9024	15.18	83.1
Y969H27	19117	16.43	82.0	8464	14.68	81.7
Retest of hybrids						
Y869H33-10	17092	17.03	83.1	7881	15.55	81.0
Y869H36-14	16257	16.88	81.9	7962	15.90	83.5
Y869H77-1	17102	17.00	83.5	8362	15.37	82.6
Y869H27-7	17415	16.23	81.2	9502	15.80	81.8
Y869H27-8	18306	16.37	84.1	7605	15.67	81.2
Y869H27-9	16650	17.10	81.7	9267	16.25	82.0
Y869H27-10	18585	16.65	80.4	9786	15.77	82.2
Y869H69-7	16457	16.55	82.3	8226	15.73	82.6
Y869H69-13	17297	16.20	82.7	8042	14.98	82.9
Y869H69-20	17404	16.40	83.0	7373	15.38	83.0
Y869H9-3	16452	16.42	82.7	7022	14.85	82.1
Mean	17508.3	16.67	82.4	8502.2	15.52	82.4
LSD (.05)	1233.9	0.55	1.7	1372.4	0.69	2.6
C.V. (%)	6.1	2.86	2.8	14.0	3.85	2.8
F Value	3.6**	3.04**	2.5**	3.3**	2.94**	0.6NS

EVALUATION OF MONOGERM LINES & POPULATIONS, SALINAS, CA., 2000

(TESTS 2800, 200, 6200)

Variety	Test 2800 (Yield)			Test 200 (NB)		Test 6200 (RZM)		
	Sugar Yield Lbs	Sucrose %	RJAP %	% Bolting 10/10	%Downey Mildew 04/03	Sugar Yield Lbs	Sucrose %	RJAP %
Checks								
99-790-15	16852	16.38	83.5	9.5	0.0	5756	16.73	85.0
99-790-68	14431	16.74	83.4	7.4	0.0	4154	17.17	84.9
Monogerm lines								
8911-4-10M	15601	17.09	79.3	0.0	0.0	4905	17.58	80.1
9869-6	16940	16.16	83.1	13.7	0.0	6821	16.95	84.8
9867-1	12589	16.29	81.6			4711	17.80	82.6
9829-3	14439	16.32	80.2			2954	16.55	80.7
9831-3	14600	16.21	83.1			7255	16.33	84.0
9831-4	16857	16.63	79.5			7311	16.95	79.7
9833-5 T-O	13068	17.11	80.6			4397	17.67	80.3
9833-5	14484	17.29	81.8			5236	17.95	82.8
9833-12	13307	15.74	83.6			4104	16.30	80.2
N965M	14474	15.79	82.2	12.8	0.0	8386	16.75	85.3
Monogerm populations								
9832	18868	16.38	83.8			8165	17.15	84.4
9835	17588	16.71	82.9	15.2	1.1	9192	16.98	85.5
9838	16630	16.19	83.1	14.3	0.0	7907	16.98	85.6
9840	17724	16.42	82.3	7.9	1.0	8345	17.45	83.7
9808	14867	16.09	83.6	16.3	0.0	3167	16.52	84.0
9818M	16079	16.51	81.9	26.3	1.6	8221	16.65	84.9
9833	13980	15.94	81.9	20.9	1.1	4737	16.75	82.5
9836	16204	16.34	82.2	4.4	0.0	7910	16.73	81.8

EVALUATION OF MONOGERM LINES & POPULATIONS, SALINAS, CA., 2000

(TESTS 2800, 200, 6200)

(cont.)

Variety	Test 2800 (Yield)			Test 200 (NB)		Test 6200 (RZM)		
	Sugar Yield	Sucrose	RJAP	% Bolting	%Downey Mildew	Sugar Yield	Sucrose	RJAP
	Lbs	%	%	10/10	04/03	Lbs	%	%
Monogerm populations (cont.)								
9835 T-O	13937	15.80	81.6	30.1	0.0	6774	16.63	82.9
9869	17193	16.19	83.0	6.3	0.0	6681	17.15	85.3
Hybrid checks								
Beta 4776R	21595	17.31	84.6			10303	17.05	84.3
9931H5	20617	17.31	82.8			12016	17.77	85.1
Mean	15955.2	16.46	82.3	23.7	1.6	6642.0	17.02	83.4
LSD (.05)	2154.0	0.58	1.4	14.2	5.7	1733.2	0.59	2.5
C.V. (%)	9.6	2.50	1.2	37.3	217.4	26.2	3.45	3.0
F value	8.9**	5.49**	7.5**	17.3**	2.0**	6.9**	2.58**	2.5**

SUGAR BEET RESEARCH

2000 REPORT

Section B

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Much of this research was supported in part by funds provided through the
Beet Sugar Development Foundation
(Projects 440, 441, 443, 446, 903, and 904)

CONTENTS

USDA-ARS-NPA Sugar Beet Research Unit's Mission Statement

Utilize distinctive site environmental and disease-free characteristics and specifically developed team expertise to: develop new knowledge and adapt biotechnologies to modify host-pathogen relations that affect disease resistance, pathogenesis, and epidemiology in sugar beet and other plant species pertinent to sugar beet cultivation; discover new information and techniques to identify and produce genotypes exhibiting superior disease and stress tolerance and agronomic qualities; and provide new knowledge that improves production efficiency and biochemical processing characteristics of sugar beet.

USDA-ARS -NPA COLORADO-WYOMING RESEARCH COUNCIL

The Sugar Beet Research Unit is a part of the Colorado-Wyoming (CO-WY)Research Council. This Council was chartered to promote and coordinate cooperative research activities among CO-WY Council research units; and facilitate communication and interaction with the Northern Plains Director, and among research programs and units and with customers locally, regionally, nationally and internationally. The five research units listed below publish an annual compilation of research reports. Many of the units are considering or have placed these reports on individual home pages which can be accessed through the NPA home page at **www.npa.ars.usda.gov**.

Rangeland Resource Research Unit (RRRU) - Cheyenne, WY, Fort Collins, CO & Nunn, CO
MISSION STATEMENT: The mission of the Rangelands Resources Research Unit is to develop an understanding of the interrelationships of the basic resources that comprise rangeland ecosystems. Research is directed toward the development of science and technology that contributes to enhanced forage and livestock production and sustainable, productive rangelands in the Central Great Plains.

Central Plains Resources Management Research Unit (CPRMRU)- Akron CO.
MISSION STATEMENT: To enhance the economic and environmental well-being of agriculture by development of integrated cropping systems and technologies for maximum utilization of soil and water resources. Emphasis is on efficient use of plant nutrients, pesticides, and water and soil conservation/preservation.

Great Plains Systems Research Unit (GPSRU) - Fort Collins, CO.
MISSION STATEMENT: Help develop and implement sustainable and adaptive agricultural systems by: (1) synthesizing, quantifying, evaluating, and enhancing knowledge of processes; (2) developing integrated models of agricultural systems; (3) providing technology packages to agricultural communities and action agencies.

Soil-Plant-Nutrient Research Unit (SPNRU) - Fort Collins, CO.
MISSION STATEMENT: To develop and evaluate new knowledge required to efficiently manage soil, fertilizer and plant nutrients (emphasis on nitrogen) to achieve optimum crop yields, maximize farm profitability, maintain environmental quality and sustain long-term productivity.

Water Management Resources Unit (WMRU) - Fort Collins, CO.
MISSION STATEMENT: Research emphasis is to integrate applied and basic principles to develop improved water, chemical, and alternative weed management systems and irrigation system designs. Improvements are directed toward sustainable, environmentally sound and efficient systems based on soil, water, fertility, energy, and weed ecology principles. This encompasses understanding physical and biological phenomena and developing computer simulation models and precision farming systems to transfer new technologies to producers, consultants, action agencies, industry, and scientists.

For a copy of the Colorado-Wyoming (CO-WY)Research Council Annual Report or information on any of these programs, please note the following contacts:

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18. Hanson, L.E. and C.R. Howell. Isolation of a plant defense elicitor from *Trichoderma virens*. Phytopathology. 90:S34 2000 (abstract)

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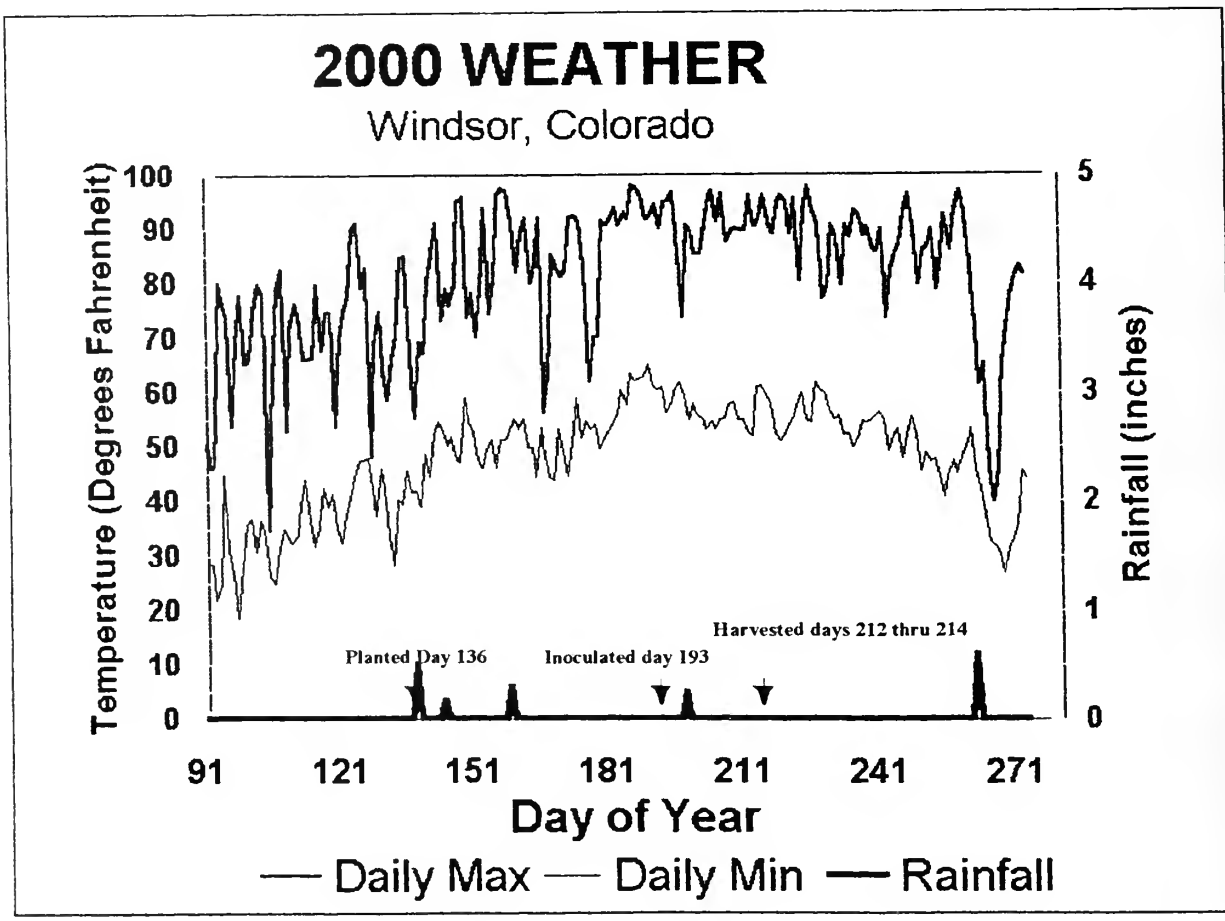
EVALUATION OF CONTRIBUTED LINES FOR RESISTANCE TO *RHIZOCTONIA SOLANI*, A CAUSAL FUNGUS OF SUGAR BEET ROOT ROT. (BSDF Project 903)

L. Panella & Linda Hanson

Annually, for over thirty years, the breeding program in Fort Collins has created an artificial epiphytotic through inoculation with *Rhizoctonia solani* to evaluate and select for resistance to root rot caused by this pathogen. We have been pleased to participate and lead this cooperative research project between the ARS, Colorado State University, and the BSDF. The project primarily involved field studies conducted on 35 acres of leased land near Windsor, CO. Randomized, complete-block designs with five replicates were used to evaluate Fort Collins ARS breeding germplasm. Rhizoctonia-resistant line FC703 and highly susceptible FC901/C817 were included as internal controls, along with highly resistant FC705-1.

One-row plots, planted May 16th, were 14 feet long with 22 inches between rows and 8-10 inches within-row spacing. Inoculation with dry, ground, barley-grain inoculum of *Rhizoctonia solani* AG2-2 isolate R-9 was performed on July 12th; immediately after inoculation, a cultivation was performed so as to throw soil into the beet crowns. The field was sprayed twice with Betamix Progress, Upbeet, and Stinger (June 2 and 12) to control weeds. The field was thinned by hand and irrigated as necessary. Beets were harvested July 31 through August 2. Each root was rated for rot on a scale of 0 to 7 (dead) as previously described. ANOVAs were performed on disease indices (DIs), percent healthy roots (classes 0 and 1 combined), and percentage of roots in classes 0 thru 3. Percentages were transformed to arcsin-square roots to normalize the data for analyses. LSDs are



provided for comparing entries with those of our internal checks.

The high temperatures in the summer of 2000 (see accompanying summary of weather data), combined with a high inoculum load, contributed to a severe root rot epidemic. The *Rhizoctonia* epidemic progressed very quickly, becoming severe by the end of July. Differences in DIs among entries in all tests were highly significant ($P < 0.001$). Mean DIs across all tests for highly resistant FC705-1, resistant FC703, and highly susceptible FC901/C817 controls were 2.5, 2.7, and 4.4 respectively. Percentages of healthy roots were 16.0, 16.3, and 3.9% for these controls. Percentages of roots in disease classes 0 thru 3 were 79.9, 67.1, and 28.7, respectively. The highest and lowest DIs for the evaluated lines were 6.4 and 1.7, respectively.

USDA-ARS 2000 Rhizoctonia Disease Nursery, Fort Collins, CO.

Table 1. 2000 Rhizoctonia Root Rot Nursery, Fort Collins, CO. The Graph above summarizes the weather data for our Rhizoctonia Root Rot Nursery in 2000. The table below presents summary data of the entire nursery. The experiment mean, the mean of the susceptible check, the mean of the resistant check, and the mean of the highly resistant check are given for each of the experiments in the nursery. LSD is at the t=0.05 level.

	Disease Index					Percent Healthy (classes 0&1)					Percent in Classes 0 to 3				
Exp.	Mean	Sus.	Res.	H. Res.	LSD	Mean	Sus.	Res.	H. Res.	LSD	Mean	Sus.	Res.	H. Res.	LSD
1R	4.5	5.4	3.7	2.7	0.8	2.9	0.0	4.9	22.7	13.2	21.7	17.6	38.3	65.2	16.9
2R	4.7	4.7	3.2	4.3	0.9	1.3	0.0	11.0	3.5	6.5	12.0	6.4	49.7	15.7	16.9
3R	4.1	5.0	2.5	2.9	0.7	3.2	0.0	17.9	3.9	7.3	39.2	10.0	80.5	68.1	16.4
4R	3.6	5.5	3.8	3.1	1.0	6.5	0.0	4.9	16.3	13.3	13.9	5.9	38.3	59.8	25.9
5R	5.0	5.8	4.2	2.7	0.5	0.4	0.0	0.0	16.9	2.4	5.1	0.0	21.6	67.2	9.5
7R	4.5	4.7	3.9	3.3	0.7	0.2	0.0	0.0	6.0	ns	17.8	7.9	36.1	52.7	17.8
8R	4.7	3.6	3.9	3.4	0.7	0.6	0.6	0.0	6.5	ns	11.5	37.5	34.9	48.7	13.5
9R	4.2	5.2	3.4	2.9	0.6	2.0	0.0	3.0	15.0	8.3	35.0	21.0	54.0	65.0	16.5
10R	3.2	4.4	2.7	2.5	0.9	13.0	3.9	16.3	16.0	17.7	61.0	28.7	67.1	79.9	22.0

Percent in Classes is the transformed value (arcsin-square root)

Mean = Experiment Mean;

Sus. = Susceptible Check (FC901/C817);

Res. = Resistant Check (FC703);

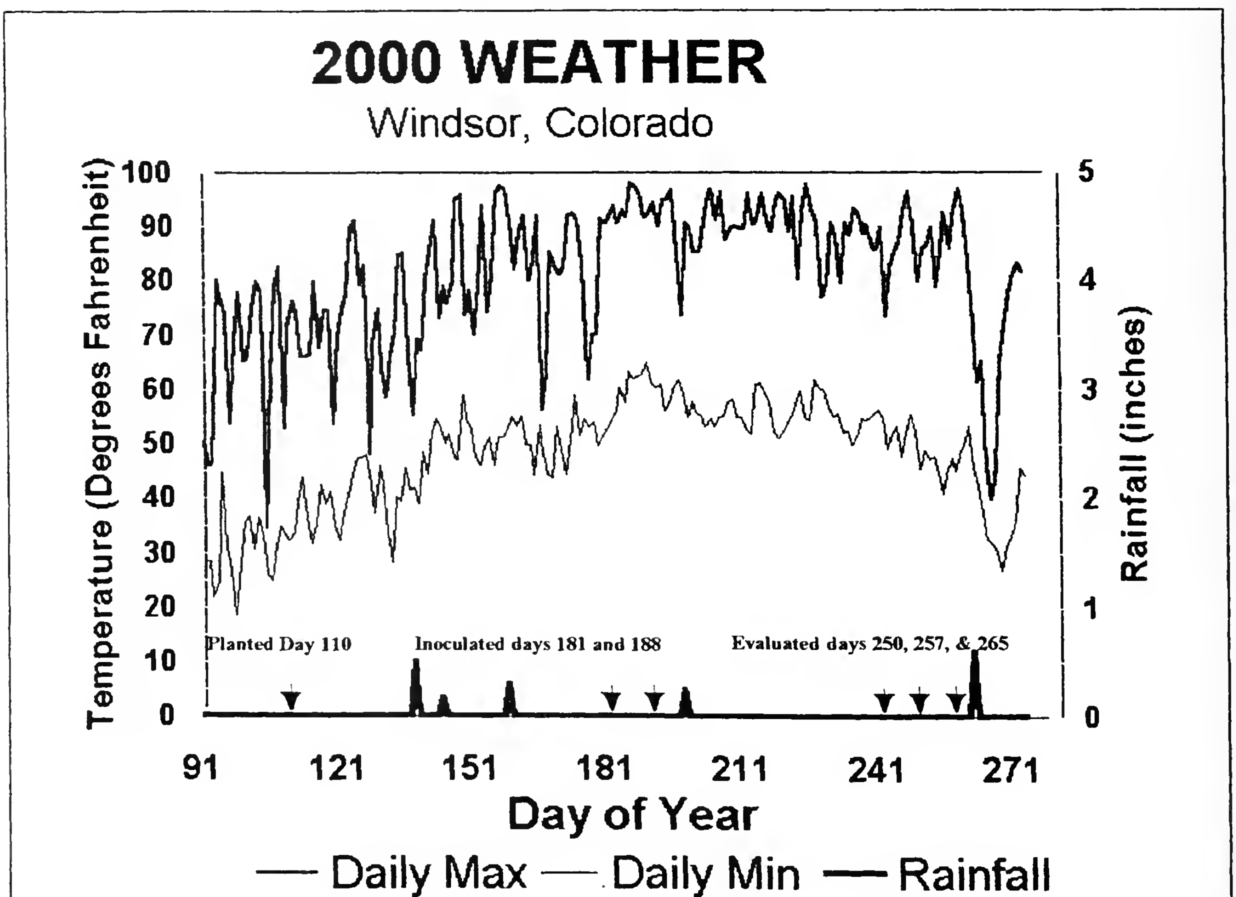
H Res. = Highly Resistant Check (FC705/1)

EVALUATION OF CONTRIBUTED LINES FOR RESISTANCE TO *CERCOSPORA BETICOLA*, CAUSAL FUNGUS OF CERCOSPORA LEAF SPOT (BSDF Project 904)

L. Panella & Linda Hanson

The breeding program in Fort Collins has created an artificial epiphytotic through inoculation with *Cercospora beticola* annually for over forty years to evaluate and select for resistance to leaf spot caused by this pathogen. We have been pleased to participate and lead this cooperative research project between the ARS, Colorado State University, and the BSDF. The project primarily involved field studies conducted on 35 acres of leased land near Windsor, CO.

Randomized complete-block designs, with three replications were used to evaluate commercial and experimental entries. Internal controls included a highly susceptible synthetic and a resistant check (FC 504/502-2//SP6322-0). Fertilization was 75% of the soil test recommendation to minimize leaf growth, which can interfere with visual evaluations. Differences among lines were highly significant in all tests at each of three evaluation dates. Two-row plots were 12 feet long, with 22-inch row spacing and an 8 - to 10-inch within-row plant spacing. The trial was planted on April 20th in Windsor, CO. Inoculation was performed on July 6th and again on July 13th. Evaluations were made on August 31st and September 7th and 14th, with the peak of the epidemic occurring on or about the last date. The field was sprayed twice with Betamix Progress, Upbeet, and Stinger (June 2nd and June 12th) to control weeds. The field was thinned by hand and irrigated as necessary.



The high temperatures in the summer of 2000, combined with very low moisture (see accompanying weather data), made it difficult to keep the humidity in the nursery high, and contributed to a mild leaf spot epidemic. The *Cercospora* epidemic was slow to develop and had not become severe enough to rate until the end of August. Disease severity had started to increase by mid September, and our next rating was expected to be more severe. However, heavy rain shortly before our fourth rating prevented entry into the field, and this was followed by snow and a frost that damaged leaves so that consistent ratings could not be made after September 24. At our third evaluation, means of the resistant and susceptible internal control were 2.4 and 3.8 (scale of 0-10), respectively, across the nursery. In 1999 (September 14), these means were 3.1 and 6.4, respectively. Means of contributor lines ranged from 1.7 to 6.0.

USDA-ARS 2000 Cercospora Disease Nursery, Fort Collins, CO.

Table 2. 2000 Cercospora Leaf Spot Nursery, Fort Collins, CO. The Graph above summarizes the 2000 weather data for our Cercospora Leaf Spot Nursery in 2000. The table below presents summary data of the entire nursery. The experiment mean, the mean of the susceptible check, and the mean of the resistant check are given for each of the experiments in the nursery, for each evaluation date. The highest mean rating given on September 14th was a 6.0 and the lowest a 1.7.

	August 31st Disease Index				September 7th Disease Index				September 14th Disease Index			
Exp.	Mean	Sus.[1]	Res.[2]	LSD	Mean	Sus.	Res.	LSD	Mean	Sus.	Res.	LSD
1A	3.2	3.5	2.5	1.11	2.7	3.2	1.5	1.32	3.5	3.8	2.5	1.15
2A[3]	3.9	3.5	1.5	2.01	3.4	3.3	1.5	1.21	4.1	3.8	2.5	1.70
3A	2.6	3.3	1.8	1.31	3.0	3.5	2.0	0.93	3.3	3.8	2.5	0.87
4A	1.5	2.0	1.2	0.93	3.0	4.2	2.0	1.31	3.2	3.7	2.2	0.97
5A	2.1	3.0	1.2	1.10	2.7	3.3	1.3	0.94	2.8	3.7	1.7	0.91
6A	2.1	1.5	2.3	1.22	3.0	2.5	3.0	0.94	3.3	2.7	3.2	0.84
7A	1.5	2.8	1.0	0.87	2.6	3.5	1.7	1.18	2.9	4.3	2.0	0.88
8A	1.5	3.5	1.8	0.90	1.9	4.3	2.8	0.91	2.5	4.0	2.5	0.99
9A[3]	1.8	3.5	1.8	1.31	2.6	4.3	2.8	1.37	3.0	4.0	2.5	1.09
Mean	**2.24**	**2.96**	**1.68**		**2.77**	**3.57**	**2.07**		**3.18**	**3.76**	**2.40**	

[1]Cercospora Susceptible Check - SP351069-0
[2]Cercospora Resistant Check - FC 504CMS/FC 502-2//SP6322-0
[3]There were only two replications of Experiments 2A & 9A.

RHIZOCTONIA ROOT ROT RESISTANCE AND DEVELOPMENT OF GENETIC RESISTANCE IN SUGAR BEET - BSDF Project 440

L. Panella

This facet of the USDA-ARS Fort Collin's sugar beet breeding program has as its goals: 1) the understanding the genetics of the *Rhizoctonia solani*/sugar beet interaction in order to better facilitate development of germplasm with high levels of resistance to Rhizoctonia and other sugar beet diseases, and 2) to provide the knowledge to better manage this disease in sugar beet production areas. It is an integrated research program with greenhouse, laboratory, and field components. Genetic information developed previously in our research is used to execute additional cycles of pathogen inoculation, plant selection, and recombination among germplasms that we have in our cyclic improvement program. Germplasms in various stages of improvement are evaluated for resistance in inoculated field tests. Results of these tests form the basis of decisions about specific germplasm, i.e., retain, shelve, discard, recombine, release, etc. Germplasms likely to be useful for variety improvement are identified and released for use by other sugar beet breeders.

2000 Field Research on Rhizoctonia Root Rot of Sugar Beet.

Annually, for over thirty years, the breeding program in Fort Collins has created an artificial epiphytotic through inoculation with *Rhizoctonia solani* to evaluate and select for resistance to root rot caused by this pathogen. We have been pleased to participate and lead this cooperative research project between the ARS, Colorado State University, and the BSDF. The project primarily involved field studies conducted on 35 acres of leased land near Windsor, CO. Randomized, complete-block designs with five replicates were used to evaluate Fort Collins ARS breeding germplasm. Rhizoctonia-resistant line FC703 and highly susceptible FC901/C817 were included as internal controls, along with highly resistant FC705-1.

One-row plots, planted May 16th, were 14 feet long with 22 inches between rows and 8-10 inches within-row spacing. Inoculation with dry, ground, barley-grain inoculum of *Rhizoctonia solani* isolate R-9 was performed on July 12th; immediately after inoculation, a cultivation was performed so as to throw soil into the beet crowns. The field was sprayed twice with Betamix Progress, Upbeet, and Stinger (June 2 and 12) to control weeds. The field was thinned by hand and irrigated as necessary. Beets were harvested July 31 through August 2. Each root was rated for rot on a scale of 0 to 7 (dead) as previously described. ANOVAs were performed on disease indices (DIs), percent healthy roots (classes 0 and 1 combined), and percentage of roots in classes 0 thru 3. Percentages were transformed to arcsin-square roots to normalize the data for analyses. LSDs are provided for comparing entries with those of our internal checks.

The high temperatures in the summer of 2000 (see accompanying summary of weather data), combined with a high inoculum load, contributed to a severe root rot epidemic. The *Rhizoctonia* epidemic progressed very quickly, becoming severe by the end of July. Differences in DIs among entries in all tests were highly significant ($P < 0.001$). Mean DIs across all tests for highly resistant FC705-1, resistant FC703, and highly susceptible FC901/C817 controls were 2.5, 2.7, and 4.4 respectively. Percentages of healthy roots were 16.0, 16.3, and 3.9% for these controls. Percentages of roots in disease classes 0 thru 3 were 79.9, 67.1, and 28.7, respectively. The highest and lowest DIs for the evaluated lines were 6.4 and 1.7, respectively.

Table 3. Allotment of Fort Collins "FC" numbers (3-digit numbers)

"FC" numbers are "convenience" numbers for "seed releases" or purposes where a permanent line designation is needed — i.e. a number that does not change from generation to generation where little or no selection pressure is applied. Initially, an "FC" no. was written thus "FC 501" [now FC727], "FC 502 CMS" [now FC715CMS], etc. Sublines (from selfing) were designated thus, "FC 502/2" [now FC709-2], "FC502/3" [now FC502-3], etc. The same applies when the line is substantially changed by selection without selfing.

Below 500	Originally LeRoy Powers - now parental lines and special genetic stocks.
500's	Leaf Spot Resistant (LSR), Type-O lines & male steriles [CMS]
600's	LSR-Curly Top Resistant (CTR), type-O lines & male steriles [CMS]
700's	Rhizoctonia Resistant
800's	LSR-CTR-Rhizoctonia resistant
900's	Pollinators, LSR-CTR type

This year, I also completed a second year of evaluation of most of the Rhizoctonia-resistant lines released from the USDA-ARS breeding project at Fort Collins (Table 4). This is a test from 2000 under the same conditions as the other contributor lines in this year's test.

Transforming Rhizoctonia-Resistant Populations to Germplasm with Multiple Disease Resistance

Root rot and leaf spot are two serious diseases of sugar beets caused by fungi (*Rhizoctonia solani* and *Cercospora beticola,* respectively). The diseases caused by these fungi may produce a severe reduction of yield in many sugar beet production areas. Cultural control measures are not adequate by themselves, and often no chemicals are registered for control of these diseases, or chemical control is expensive or environmentally unsafe. Increased levels of genetic resistance in sugar beet varieties are needed to minimize growers' losses from these diseases. In a hybrid crop like sugar beets, it is preferable that all of the parents contain some level of resistance to diseases prevalent in the area in which the hybrid is to be grown. Multiple disease resistance is a difficult goal in a crop improvement program, especially when working with an outcrossing species. In alternating generations of selection, some of the progress made in resistance to one disease is lost while selecting for resistance to other diseases.

One way of solving the problem of selecting for multiple disease resistance is the use of progeny testing. By testing the progeny of individual mother roots, plants with multiple disease resistance can be identified and used as parents of the next generation. The most efficient use of progeny testing is when the genotype of both parents is controlled, and the most effective way to do

this is through self-pollination. In sugar beet, there is a dominant, self-fertility gene that permits self-pollination. Used in conjunction with genetic male sterility, to insure cross pollination, a system of selfed-family progeny testing can be utilized.

This effort is based on the Rhizoctonia-resistant materials from the programs of John Gaskill and Richard Hecker, and disease resistant germplasm from other sources to produce germplasm highly resistant to Rhizoctonia solani. This base of Rhizoctonia-resistant germplasm is being combined with material from the USDA-ARS breeding programs at Salinas and Fargo, as well as with sources for higher yield and sucrose. The Salinas material has the self-fertility allele, is segregating for genetic male sterility, and also contains a broad spectrum of resistance to diseases of importance in California as well as other sugar beet production areas (including rhizomania, powdery mildew, virus yellows, and curly top virus). Fargo sources of root maggot and Cercospora leaf spot resistance also are being utilized.

A number of source populations are being developed. The germplasm, FC712(4X) has been released in 2000. This germplasm was developed in our research project that has been contributed to, in kind, by the Beet Sugar Development Foundation. This tetraploid pollinator germplasm combines excellent Rhizoctonia-root-rot resistance with a good level of Cercospora leaf spot resistance. Populations whose development was begun under the breeding program of Dr. Richard Hecker are still being evaluated and selected in the field. These germplasms and other germplasms from the Fort Collins program were field-tested in summer of 2000 for resistance to *R. solani* (Tables 4-5), *C. beticola* (Tables 6-8), and the curly top virus (Table 9). More germplasms that were selected for increased resistance to Rhizoctonia-root-rot in 1999, and tested in 2000, will be tested again in 2001; and the most promising of these will be released in the future.

There currently are four major groups of Rhizoctonia-resistant germplasms currently under development.

1. Germplasms developed in Dr. Hecker's breeding program for resistance to Rhizoctonia root rot and Cercospora leaf spot are being field tested and selected in the Rhizoctonia root rot nursery at Fort Collins (also in the Cercospora leaf spot and curly top nurseries).

2. Rhizoctonia-resistant monogerm polycross base population developed by a cross between FC708 and two Salinas germplasms, 2890 and 2859.
   - 2890 (sp) 0790 *mm aa* x 1890 (Salinas); is seed from *aa* plants [i.e., male sterile] open pollinated by A- plants. 0790 = population-790 cycle 5 synthetic by S_1 progeny, M.S. mm, O-type, good combining ability, adapted to California, S^f,. 1890 = BC population to population 790 to get Rz equivalent, remains variable for M-:mm, Rz-:rzrz, etc.

   - 2859 m (sp) = 1859, 1859R aa x A- (Salinas); Released in 1992 as C859. S^f, similar to 2890, but should have higher curly top resistance (CTR). Segregates and variable for M-:mm, Rz-:rzrz, A-:aa, predominant background is lines like C563, which is widely used in western USA as source of CTR, mm, O-type.

3. Rhizoctonia root rot resistance multigerm base population developed by a cross between FC709-2 and a Salinas germplasms, 2915.
   - 2915 (sp) RZM 1915-#m 1913-# aa x A (Salinas); Seed harvested from aa (ms) plants open-

pollinated by A- (fertile) plants. This population will segregate for A-:aa, Rz-:rzrz, $s^s s^s$:s^f-, (>½ s^f), R-:rr, It will be multigerm, have moderate to good tolerance to virus yellows, curly top, bolting, Erwinia; variable for reaction to powdery mildew, production traits. Individual plants will be either As or aa. Background of population is mostly from OP, MM lines such as C46, C37.

4. Combination Rhizoctonia root rot and Cercospora leaf spot resistant multigerm pollinator population from FC907 (out of Fargo) and FC709-2.

Progress in 2000

1. Selections have been made in these populations and they have been crossed with other germplasm in a continuing *Rhizoctonia*-resistance breeding effort. One tetraploid multigerm pollinator [FC712 4(X)] was released. It has excellent resistance to Rhizoctonia root rot and good Cercospora resistance. Three to five monogerm O-type lines with and without and CMS equivalents, selected in the 1996 Rhizoctonia nursery were re-tested and increased and will be released this winter.

2. This population has been divided into three breeding lines. One has been selected for resistance to curly top (selfed progeny tested in Kimberley, ID) and Rhizoctonia (individual plants selected in the Fort Collins nursery), and is currently being increased for testing and re-selection. Another population has been selected for resistance only to Rhizoctonia (individual plants selected in the Fort Collins nursery), and is currently being increased for testing and re-selection. The third line was selected for Rhizomania resistance and agronomic performance (individual plants selected in the Salinas nursery) and is currently being re-selected (August 2000 planting in Salinas).

3. This population has been divided into four breeding lines selected in Fort Collins, CO, and Kimberley, ID. Two have been selected for resistance to Rhizoctonia (individual plant selections and half-sib families selections), one was selected for resistance to Rhizoctonia and curly top virus (half-sib families selections), and one was selected for resistance to curly top (half-sib families selections). Three of the populations were planted in August in Dr. R. Lewellen's Rhizomania/steckling nursery for selection for resistance to rhizomania (Holly gene source) and for agronomic performance. Selected roots will be increased for further testing and release.

4. Seed, increase from Rhizoctonia-resistant selected roots of FC907 ((FC701 x FC607)BC_4), was tested in the Rhizoctonia and Cercospora nurseries. Selections made in a (FC709-2 x FC907)F_2 population in the Rhizoctonia nursery were increased in the greenhouse and tested in the Rhizoctonia and curly top nurseries. This population will be re-selected in the Rhizoctonia nursery and then tested in the Rhizoctonia, Cercospora, and curly top nurseries.

Future laboratory research will use the information gained from studying the pathogen *Rhizoctonia solani* to begin to look at the sugar beet reaction to this pathogen.

Table 4. Experiment 4R, 2000. Rhizoctonia Resistance Evaluation of USDA-ARS Breeding Lines Fort Collins, CO.

		Description	DI[1]	% Hlthy[2]	% 0 - 3[3]	Z%[4] Hlthy	Z% 0 - 3[4]
		LSD[5]	0.95			13.30	25.90
931017		**Susceptible Check[6]**	**5.5**	**0**	**3**	**0.0**	**5.9**
831083	**FC705/1**	**Highly Resistant Check[7]**	**3.1**	**13**	**69**	**16.3**	**59.8**
751080H	**FC703**	**Resistant Check[8]**	**3.8**	**3**	**39**	**4.9**	**38.3**
		Experiment Mean	**3.6**	**5**	**48**	**6.5**	**43.9**
97A004	EL 48		4.5	0	17	0.0	19.0
99A003	EL 52	98J26-052	3.9	3	31	6.8	30.6
931024	FC701		3.7	0	36	0.0	33.4
761068H	FC701-4		3.2	3	60	4.2	50.8
721056	FC701-5		3.4	12	49	10.2	47.3
801059H	FC701-6		3.1	11	56	11.8	46.1
991016	FC702/2		3.6	6	49	10.8	44.5
681009-0	FC702		4.1	0	33	0.0	30.0
811055H	FC702-6		3.1	16	58	12.7	52.7
931021	FC704		3.3	5	63	8.4	53.4
781066H	FC705		3.3	3	63	4.2	52.6
831085HO	FC708		3.5	2	57	3.7	49.2
891026H	FC709		2.2	25	98	29.4	86.5
921024	FC709-2	Fort Collins release (+ 2 cycles Rhizoc & 1 cycle sucrose)	2.8	11	81	15.1	70.1
891033	FC710		3.5	2	54	3.7	47.8
971017	FC710(4X)	FC710 colchicine doubled	3.6	0	32	0.0	30.7
821087	FC711		3.5	0	53	0.0	46.9
881032H	FC712	Fort Collins Release	3.7	5	42	6.0	37.4
971018	FC712(4X)	FC 712 colchicine doubled	3.0	6	69	9.3	60.2
911026HO	FC715		4.3	2	33	3.5	34.4
971019	FC716		3.1	9	63	13.0	55.6
981025	FC717		4.3	0	19	0.0	20.3
911032	FC718		3.0	2	78	3.3	65.9
911037	FC719		2.8	9	69	15.3	57.4
961015	FC720-1	C718/(C718/FC708)	4.0	3	36	4.6	36.1
961010HO	FC722-1	C718/FC708	4.2	0	25	0.0	26.1
961010HO1	FC722CMS	C718/FC708	4.2	0	19	0.0	17.2
951016HO	FC723	EL44/FC708 mm	4.1	2	28	3.5	31.3

Table 4. Experiment 4R, 2000. Rhizoctonia Resistance Evaluation of USDA-ARS Breeding Lines Fort Collins, CO.

		Description	DI[1]	% Hlthy[2]	% 0 - 3[3]	Z%[4] Hlthy	Z% 0 - 3[4]
		LSD[5]	0.95			13.30	25.90
931017		**Susceptible Check[6]**	**5.5**	**0**	**3**	**0.0**	**5.9**
831083	**FC705/1**	**Highly Resistant Check[7]**	**3.1**	**13**	**69**	**16.3**	**59.8**
751080H	**FC703**	**Resistant Check[8]**	**3.8**	**3**	**39**	**4.9**	**38.3**
		Experiment Mean	**3.6**	**5**	**48**	**6.5**	**43.9**
951016HO1	FC723CMS	EL44/FC708 CMS	4.3	0	33	0.0	30.2
961014	FC724-1	FC702/LSR-CTR	3.1	5	67	6.0	61.7
921008	FC725		3.3	4	60	5.5	51.6
931010	FC726		2.7	19	79	22.1	66.2
951017	FC727	Release (FC703/(AJ-ZZ & Aula Dei & 67-436), MM)	3.7	4	45	7.4	42.8
921025	FC728		3.4	6	54	10.9	48.1
921019	FC729	FC712/A4, 3 cycles Rhizoc, MM	3.5	6	55	8.7	50.8
991015	FC801		3.9	0	45	0.0	44.7
971020	FC907-1	FC607/FC701 BC4 - 1 cycle of RhzcR sel	4.8	0	11	0.0	16.8

[1]Disease Index is based on a scale of 0 (=healthy) to 7 (= plant dead).
[2]Percent of healthy roots (disease classes 0 and 1 combined).
[3]Percent of diseased roots likely to be taken for processing (disease classes 0 through 3 combined).
[4]Percentages were transformed to arcsin-square roots to normalize the data for analyzes.
[5]P=0.05 – Due to missing values, only 194 or 200 observations can be used in this analysis (40 entries & 5 replications), therefore this lsd is an estimate based on 5 replications in each trial.
[6]FC901/C817
[7]FC705/1
[8]FC703

Table 5. Experiment 10R, 2000. Rhizoctonia Resistance Evaluation of USDA-ARS Breeding Lines, Fort Collins, CO; and East Lansing, MI.

Description	Seed Source	Location	DI[1]	% Hlthy[2]	% 0 - 3[3]	Z%[4] Hlthy	Z% 0 - 3[4]
		LSD[5]	0.88			17.70	21.96
98J38-00	98J38-00	East Lansing	4.9	0	33	0.0	31.6
98J41-01	98J41-01	East Lansing	3.2	9	65	13.9	54.3
99J04-00	99J04-00	East Lansing	3.3	8	72	10.1	61.6
99J12-01	99J12-01	East Lansing	3.2	5	68	10.2	57.1
00J02-00	00J02-00	East Lansing	3.3	7	67	11.6	55.4
00J03-01	00J03-01	East Lansing	2.6	11	85	12.4	72.6
Rzm 8931aa x A – Sp5	9931	Salinas	4.0	3	41	4.2	40.0
Rzm 8932aa x A – Sp7	9932	Salinas	4.7	0	29	0.0	29.2
Rzm 8933aa x A – Sp3	9933	Salinas	4.5	0	31	0.0	33.2
Rzm 8835mmaa x A – Sp13	9835	Salinas	3.8	3	44	4.9	40.8
(FC907 x FC709-2)F3-sel Rhzc (981009H increase)	001002	Fort Collins	3.7	10	43	9.0	42.9
(FC907 x FC709-2)F2-RhzcR sel-hs	001008	Fort Collins	2.6	5	96	6.0	84.7
(FC907 x FC709-2)F2-RhzcR sel-hs	001009	Fort Collins	4.4	3	41	4.4	39.5
Rhizoctonia Resistant Multigerm pop (2915/FC709-2)	991014	Fort Collins	2.6	9	87	11.3	74.0
FC712(4X) FC 712 colchicine doubled	971017	Fort Collins	2.6	7	93	7.0	83.0
FC710(4X) FC710 colchicine doubled	971018	Fort Collins	1.9	35	100	35.6	90.0
FC712 Fort Collins Release	881032H	Fort Collins	1.7	45	100	38.9	90.0
FC709-2 Fort Collins release	921024	Fort Collins	2.0	34	98	35.2	86.1
FC727 Fort Collins release	951017	Fort Collins	2.4	23	90	22.3	78.9
FC710	891033	Fort Collins	2.3	23	95	25.5	81.8
Susceptible Check	**931017**	**FC901/C817**	**4.4**	**2**	**29**	**3.9**	**28.7**
Highly Resistant Check	**831083**	**FC705/1**	**2.5**	**17**	**88**	**16.0**	**79.9**
Resistant Check	**751080H**	**FC703**	**2.7**	**13**	**77**	**16.3**	**67.1**
Experiment Mean			**3.2**	**12**	**68**	**13.0**	**61.0**

[1]Disease Index is based on a scale of 0 (=healthy) to 7 (= plant dead).
[2]Percent of healthy roots (disease classes 0 and 1 combined).
[3]Percent of diseased roots likely to be taken for processing (disease classes 0 through 3 combined).
[4]Percentages were transformed to arcsin-square roots to normalize the data for analyzes.
[5]P =0.05

CERCOSPORA LEAF SPOT RESEARCH AND BREEDING FOR CERCOSPORA AND CURLY TOP RESISTANCE - (BSDF Project 441)

L. Panella

This element of the breeding program at Fort Collins is devoted to the development of germplasm with resistance to more than one sugar beet disease and improved agronomic characteristics. It is built on germplasm developed at Fort Collins over the last fifty years for combined resistance to Cercospora leaf spot and the curly top virus. This is an integrated breeding program with greenhouse and laboratory studies, and a field program based on testing in an artificial epiphytotic created in the unique Fort Collins environment. It involves close collaboration with the other USDA-ARS sugar beet programs in the U.S. and sugar beet seed industry customers. The major goals of this program are: 1) the development of sugar beet germplasm with resistance to more than one disease and excellent agronomic characteristics; 2) the improvement of breeding techniques, traditional and molecular, to develop this germplasm; and 3) an increased understanding of the sugar beet/pathogen interactions to improve management practices of these diseases in sugar beet production areas. Genetic information developed during this research will be used to execute additional cycles of pathogen inoculation, plant selection, and recombination among germplasms that we have in our leaf spot improvement program. Results of these tests will be the basis of decisions about specific germplasm, i.e., retain, discard, recombine, release, etc. Germplasms likely to be useful for variety improvement will be identified and released for use by other sugar beet breeders.

Increased resistance to *Cercospora* continues to be an extremely important goal. If the level of resistance available in most Cercospora-resistant experimental lines were present in commercial hybrids (along with good sugar and seed yield), the need for fungicides would be greatly reduced. That continued improvement in genetic resistance to this serious pathogen is still needed is evident by the occurrence of *Cercospora* strains that are resistant or increasingly tolerant to our most potent fungicides. Additionally, some of these fungicides may be removed from the market because of their perceived or real threat to the environment. In many areas where Cercospora leaf spot is a problem, the curly top virus also causes significant losses. And, there are some growing areas in which combined resistance to Cercospora leaf spot, Rhizomania, curly top, Rhizoctonia root rot, and other diseases are desirable. Germplasm is needed with combined resistance to these diseases, along with good combining ability for yield components.

2000 Field Research on Cercospora Leaf Spot of Sugar Beet

The breeding program in Fort Collins has created an artificial epiphytotic through inoculation with *Cercospora beticola* annually for over forty years to evaluate and select for resistance to leaf spot caused by this pathogen. We have been pleased to participate and lead this cooperative research project between the ARS, Colorado State University, and the BSDF. The project primarily involved field studies conducted on 35 acres of leased land near Windsor, CO.

Randomized complete-block designs, with three replications were used to evaluate commercial and experimental entries. Internal controls included a highly susceptible synthetic and a resistant check (FC 504/502-2//SP6322-0). Fertilization was 75% of the soil test recommendation to minimize leaf growth, which can interfere with visual evaluations. Differences among lines were highly significant in all tests at each of three evaluation dates. Two-row plots were 12 feet long, with 22-inch row spacing and an 8 - to 10-inch within-row plant spacing. The trial was planted on April

20th in Windsor, CO. Inoculation was performed on July 6th and again on July 13th. Evaluations were made on August 31st and September 7th and 14th, with the peak of the epidemic occurring on or about the last date. The field was sprayed twice with Betamix Progress, Upbeet, and Stinger (June 2nd and June 12th) to control weeds. The field was thinned by hand and irrigated as necessary.

The high temperatures in the summer of 2000, combined with very low moisture (see accompanying weather data), made it difficult to keep the humidity in the nursery high, and contributed to a mild leaf spot epidemic. The *Cercospora* epidemic was slow to develop and had not become severe enough to rate until the end of August. Disease severity had started to increase by mid September, and our next rating was expected to be more severe. However, heavy rain shortly before our fourth rating prevented entry into the field, and this was followed by snow and a frost that damaged leaves so that consistent ratings could not be made after September 24. At our third evaluation, means of the resistant and susceptible internal control were 2.4 and 3.8 (scale of 0-10), respectively, across the nursery. In 1999 (September 14), these means were 3.1 and 6.4, respectively. Means of contributor lines ranged from 1.7 to 6.0.

Cercospora/Curly Top-Resistant Populations with Resistance to Multiple Sugar Beet Diseases and Superior Agronomic Characteristics

Advanced breeding lines or Cercospora-resistant germplasms from Salinas (16), East Lansing (15), and Fort Collins (9) were evaluated in Experiment 7A at the ARS leaf spot nursery at Ft. Collins (Table 6). A group of families segregating for resistance to sugarbeet root maggot and cercospora leaf spot also was evaluated by Larry Campbell - USDA-ARS at Fargo, ND along with Fort Collins releases and other Fargo experimental lines (Experiment 9A, Table 8). An additional 51 Fort Collins advanced breeding lines or released germplasms were evaluated for Cercospora leaf spot resistance in Experiment 8A (Table 7). Breeding lines and family progeny were also tested at the BSDF Nursery in Kimberly, ID (Table 9).

Cercospora Leaf Spot/Curly Top Resistant (LSR/CTR) Breeding Populations Currently under Development.

1. Cercospora leaf spot and curly top resistant monogerm base population from a polycross of FC607 and FC604 with two Salinas germplasms 2859 and 2890.

   2890 (sp) = 0790 *mm aa* x 1890 (Salinas); is seed from *aa* plants open pollinated by A- plants. 0790 = population-790 cycle 5 synthetic by S_1 progeny, *aa*, mm, O-type, good combining ability, adapted to California, S^f. 1890 = BC population to population 790 to get Rz equivalent, remains variable for M-:mm, Rz-:rzrz, etc.

   2859 m (sp) = 1859, 1859R aa x A- (Salinas); Released in 1992 as C859. S^f, similar to 2890, but should have higher curly top resistance. Segregates and variable for M-:mm, Rz-:rzrz, A-:aa, predominant background is lines like C563.

2. Cercospora leaf spot and curly top resistant multigerm base population from a polycross of FC902 with two Salinas germplasms 278 and 4918.

   278 (Iso 83) = RZM R078; R278 is Rz (segregates Rz--:rzrz) version of C46. It should be S^sS^s, MM.

4918 (sp) = RZM 3918aa X A-, 142 aa plants; This is an increase of released material C918. It should be Multigerm, over 75% S^f and segregating for A-, R-, Rz-, VY, CT, Erw, & PM.

3. Cercospora leaf spot and curly top resistant multigerm, self-incompatible base population from a polycross of FC607 x [SR87, MonoHy A4, MonoHy T6, & MonoHy T7]

4. Seed from FC709-2 x FC907 was sent to Larry Campbell at Fargo to cross to Sugar beet root maggot resistant germplasm to develop a population that will produce pollinators with resistance to Rhizoctonia, Cercospora, and Root maggot.

5. Two tetraploid pollinators (FC6064X and FC6074X) were crossed to a high sucrose tetraploid population in order to produce a tetraploid Cercospora resistant pollinator population with better combining ability.

<u>Progress in 2000</u>

Advanced breeding lines of *Cercospora* resistant germplasms were evaluated in the ARS leaf spot nursery at Ft. Collins. These lines are part of the resistant germplasm development effort in which a new germplasm should be released from the "pipeline" every two to four years. The above populations currently are in different stages of development.

1. Selections were made among half-sib progeny rows of the monogerm population. Families were selected based on leaf spot resistance, curly top resistance, and combined leaf spot and curly top resistance. They have been increased, tested, and re-selected. They have been selected for rhizomania (Holly gene source) and agronomic performance Salinas. Selected roots have been recombined and are being retested. Selections are also being O-type screened for release.

2. Plants (F_2) from the CTR/LSR multigerm cross (2) are being tested for resistance to Rhizoctonia and Cercospora. This seed has been bulk increased and crossed with a number of other leaf spot, rhizomania resistant and high sources populations. The resulting population will be a source of curly top resistant multigerm pollinators with leaf spot and Rhizomania resistance. This cross has been planted in the Salinas rhizomania resistance for selection for rhizomania resistance and agronomic performance.

3. Plants (F_2) from the Fort Collins and Fargo joint project (3) were grown in the breeding nursery and these roots were planted in Masonville selfed, taking advantage of the 'pseudo self-fertility' that occurs in this environment. This selfed seed was progeny tested in 1999. The most resistant families were recombined and will be tested and released. This population will be a source of highly leaf spot resistant multigerm pollinators with curly top resistance and good combining ability for agronomic traits.

4. Seed from (FC709-2 x FC907)F_2 has been sent to Larry Campbell at Fargo to cross to Sugar beet root maggot resistant germplasm, selected for Rhizoctonia resistance and crossed to high sucrose sources. These populations pollinators with resistance to Rhizoctonia, Cercospora, and Root

maggot. Currently root maggot resistant families are being screened for Leaf spot resistance and other of these populations tested for resistance to Rhizoctonia root rot and Cercospora leaf spot.

5. Bulked F_2 seed was planted in the Rhizoctonia and curly top nursery and half-sib families in the Cercospora nursery. The F_2 has been bulk increased and F_3 seed will be planted in the 2001 Cercospora nursery to select for sucrose and resistance to Cercospora leaf spot.

The seed from the above mentioned populations will be developed and advanced after testing. Development of a resistant germplasm line generally takes 7 years. A longer time may be necessary to incorporate multiple disease resistances. In an established program, a "pipeline" of lines in various stages of development and evaluation is the norm. Hence, the release of new germplasm usually occurs every 2 to 4 years.

Genetic information developed in this research will be used to execute additional cycles of pathogen inoculation, plant selection, and recombination among germplasms that we have in our leaf spot improvement program. Results of these tests will be the basis of decisions about specific germplasm, i.e., retain, discard, recombine, release, etc. Germplasms likely to be useful for variety improvement are identified and released for use by other sugar beet breeders. Breeding techniques are compared in developing these germplasm and information on the efficacy and efficiency of these techniques generated.

Table 6. Experiment 7A, 2000. Leaf Spot Evaluation of USDA-ARS Fort Collins, Salinas, and East Lansing breeding lines.

Entry		Identification	Disease Index[1] Aug. 30th	Sept. 7th	Sept. 14th
		$LSD_{0.05}$	0.87	1.18	0.88
LSS [2] (931002)			2.8	3.5	4.3
LSR [3] (821051H2)			1.0	1.7	2.0
Trial Mean			1.5	2.6	2.9
831085HO	released	FC708	1.0	2.3	2.0
CR909-3	Salinas - RL	R709-1aa x CR811(c)	1.0	2.0	2.2
00J03s4220	East Lansing - JS	00J08s4220	1.0	2.3	2.3
00J04-00	East Lansing - JS	00J04-00	1.2	2.3	2.3
CR909-2	Salinas - RL	R709-1aa x CR811(c)	1.0	2.3	2.3
951017	released	FC727	1.0	2.7	2.3
00J08s3	East Lansing - JS	00J08s3	1.2	2.8	2.5
921024	released	FC709-2	1.2	1.7	2.5
CR910-3	Salinas - RL	R710aa x CR811(c)1.0000	1.0	2.3	2.5
00J02-00	East Lansing - JS	00202-00	1.0	1.7	2.7
99J12-01	East Lansing - JS	99J12-01	1.3	2.7	2.7
99J28-00	East Lansing - JS	99J28-00	1.0	2.3	2.7
00J03s3720	East Lansing - JS	00J03s3720	1.2	2.3	2.7
00J03-01	East Lansing - JS	00J03-01	1.3	1.8	2.7
CR909-1	Salinas - RL	R709-1aa x CR811(c)	1.0	2.5	2.7
981025	released	FC717	1.3	2.7	2.7
99J02-00	East Lansing - JS	99J02-00	1.5	2.3	2.7
911026HO	released	FC715	1.2	1.8	2.7

Table 6. Experiment 7A, 2000. Leaf Spot Evaluation of USDA-ARS Fort Collins, Salinas, and East Lansing breeding lines.

Entry	Identification		Disease Index[1] Aug. 30th	Sept. 7th	Sept. 14th
		$LSD_{0.06}$	**0.87**	**1.18**	**0.88**
LSS[2] (931002)			**2.8**	**3.5**	**4.3**
LSR[3] (821051H2)			**1.0**	**1.7**	**2.0**
Trial Mean			**1.5**	**2.6**	**2.9**
99J04-00	East Lansing - JS	99J04-00	1.0	2.3	2.7
97A050	released	FC607	1.5	2.3	2.7
921021	released	FC703-5	1.3	2.5	2.7
CR911-4	Salinas - RL	CR811aa x CR811(c)1.1667	1.2	2.3	2.8
CR911-5	Salinas - RL	CR811aa x CR811(c)	1.3	2.7	2.8
CR910-2	Salinas - RL	R710aa x CR811(c)	1.5	2.5	2.8
CR911(c)	Salinas - RL	CR811(c)aa x A	1.7	2.8	3.0
CR909-4	Salinas - RL	R709-1aa x CR811(c)	1.5	2.8	3.0
CR911-1	Salinas - RL	CR811aa x CR811(c)1.6667	1.7	2.5	3.0
CR911-2	Salinas - RL	CR811aa x CR811(c)1.5000	1.5	2.7	3.0
921022	+ 7 cycles Rhizoc	FC702-7	1.8	2.8	3.0
00J08s33	East Lansing - JS	00J08s33	1.7	3.3	3.2
00J08s18	East Lansing - JS	00J08s18	1.5	2.3	3.2
CR910-1	Salinas - RL	R710aa x CR811(c)	1.7	2.5	3.3
921025	released	FC728	1.2	2.7	3.3
98J38-00	East Lansing - JS	98J38-00	1.8	3.7	3.3
9931	Salinas - RL	RZM 8931aa x A	1.8	2.5	3.3
CR911H6	Salinas - RL	8833-5HO x CR811(c)	1.7	3.7	3.5
98J41-01	East Lansing - JS	98J41-01	2.3	3.5	3.7
CR911-3	Salinas - RL	CR811aa x CR811(c)1.8333	1.8	3.3	3.7
00J08s6	East Lansing - JS	00J08s6	3.0	3.7	4.2
Beta 4430R	Salinas - RL	susceptible check, L4430. 8052	3.5	4.7	4.8

[1]Disease Index is based on a scale of 0 (=healthy) to 10 (=dead).
[2]The Leafspot Susceptible Check is SP351069-0.
[3]The Leafspot Resistant Check is ((FC504CMS x FC502/2) x SP6322-0).

Table 7. Experiment 8A, 2000. Leaf Spot Evaluation of USDA-ARS Fort Collins lines.

Entry	Seed Source	Identification	Disease Index[1] Aug. 30th	Sept. 7th	Sept. 14th
		$LSD_{0.05}$	0.90	0.91	0.99
LSS [2]	(931002)		3.5	4.3	4.0
LSR [3]	(821051H2)		1.8	2.8	2.5
Trial Mean			1.5	1.9	2.5
1631	861039	FC712	1.7	2.0	2.2
1632	981025	FC717	1.3	2.2	2.5
1633	921021	FC703-5	1.5	1.7	2.0
1634	921022	FC702-7 – + 7 cycles Rhizoc	1.7	1.7	2.5
1635	921024	FC709-2	1.0	1.7	1.8
1636	921025	FC728	1.8	2.2	3.0
1637	951014	(2890aa & 2859aa) x FC708	1.7	2.3	2.8
1638	951017	FC727	1.0	1.3	2.3
1639	961015	FC720-1 – C718//(C718/FC708)	1.3	2.5	2.7
1640	971017	FC710 (4X)	1.3	2.3	2.7
1641	971018	FC712 (4X)	1.0	2.0	2.3
1642	971020	FC907-1 – FC607/FC701 BC4	1.2	1.5	2.2
1643	981010H		1.3	2.2	1.8
1644	981012		3.3	3.2	3.5
1646	981032		1.5	1.7	2.3
1647	981035		1.5	1.7	2.8
1648	981037		1.7	2.0	2.7
1649	991011		1.3	1.0	2.0
1650	991012		1.5	1.3	2.3
1651	991013		1.0	1.7	2.7
1653	991014	Rhizoc. Res. Multigerm pop (2915/FC709-2)	1.3	1.7	2.0
1654	991015	FC 801	1.8	2.0	2.5
1655	991016		1.0	1.7	2.8
1656	991018	FC709	1.2	1.7	2.3
1657	991019	FC711	3.5	3.2	3.8
1658	831085HO	FC708	1.0	1.7	2.0
1659	911026HO	FC715	1.0	1.0	1.7
1660	951016HO	FC723 – EL44/FC708 mm	1.7	1.8	2.7
1661	951016HO1	FC723CMS – EL44/FC708 CMS	1.3	1.8	2.3
1662	961010HO	FC722-1 – C718/FC708	1.5	1.3	2.3
1663	961010HO1	FC722CMS – C718/FC708 CMS	1.7	2.3	2.7
1664	961011HO	FC607/FC708	1.2	2.2	3.0
1665	961011HO1	FC607/FC708CMS	1.0	1.7	2.0
1666	961012HO	FC712/MonoHy A4	1.5	2.0	3.0
1667	961012HO1	FC712/MonoHy A4 - CMS equivalent	1.3	1.8	2.5
1668	961013HO	FC506			
1669	97A050	FC607	1.0	1.7	2.0
1670	981009H		1.3	1.3	2.5
1671	981011H		2.0	2.7	3.3
1672	991002PF		1.8	1.7	2.8
1673	991003H		2.0	2.0	2.7
1674	991003H2		1.8	2.7	3.2

Table 7. Experiment 8A, 2000. Leaf Spot Evaluation of USDA-ARS Fort Collins lines.

Entry	Seed Source	Identification	Disease Index[1] Aug. 30th	Sept. 7th	Sept. 14th
		$LSD_{0.06}$	0.90	0.91	0.99
LSS[2]	(931002)		3.5	4.3	4.0
LSR[3]	(821051H2)		1.8	2.8	2.5
Trial Mean			1.5	1.9	2.5
1675	991026MS		1.0	1.7	2.3
1676	991026PF		1.0	1.3	2.3
1677	991030MS		1.0	1.5	2.0
1678	991031PF		1.0	2.0	2.7
1679	991032MS		1.7	2.3	2.2
1680	001001	RhzcRmmpop (991001)	1.5	2.0	2.7
1681	001002	(FC907 x FC709-2)F3-sel (981009H)	1.8	2.3	2.7
1682	001004	LSR/CTRMM x LSRFargo (981036)	1.3	1.7	2.5
1683	001006	LSR(4x) x Sucrose(4X)	1.0	2.0	2.0
1684	931002	LSS = synthetic check	2.7	2.7	3.7
1685	821051H2	LSR	1.2	1.7	2.3

[1]Disease Index is based on a scale of 0 (=healthy) to 10 (=dead).
[2]The Leafspot Susceptible Check is SP351069-0.
[3]The Leafspot Resistant Check is ((FC504CMS x FC502/2) x SP6322-0).

Table 8. Experiment 9A, 2000. Leaf Spot Evaluation of USDA-ARS Fort Collins and Fargo breeding lines.

Entry		Identification	Disease Index[1] Aug. 30th	Sept. 7th	Sept. 14th
		$LSD_{0.06}$	1.31	1.37	1.09
LSS[2]	(931002)		3.5	4.3	4.0
LSR[3]	(821051H2)		1.8	2.8	2.5
Trial Mean			1.8	2.6	3.0
1701	99N0006-2	F1015/961009, F_3	2.0	2.5	3.0
1702	99N0006-3	F1015/961009, F_3	1.8	3.0	3.0
1703	99N0006-4	F1015/961009, F_3	1.8	2.5	3.0
1704	99N0006-5	F1015/961009, F_3	1.0	2.3	3.0
1705	99N0006-8	F1015/961009, F_3	1.0	1.5	2.5
1706	99N0006-9	F1015/961009, F_3	2.3	2.3	3.0
1707	99N0006-11	F1015/961009, F_3	1.8	2.5	3.0
1708	99N0006-12	F1015/961009, F_3	2.5	2.5	3.3
1709	99N0006-13	F1015/961009, F_3	1.0	1.5	2.0
1710	99N0006-15	F1015/961009, F_3	1.0	1.5	2.0
1711	99N0006-16	F1015/961009, F_3	1.5	2.5	2.8
1712	99N0006-17	F1015/961009, F_3	1.8	2.5	2.8
1713	99N0006-18	F1015/961009, F_3	1.5	2.5	3.0
1714	99N0006-19	F1015/961009, F_3	1.3	2.3	2.5

Table 8. Experiment 9A, 2000. Leaf Spot Evaluation of USDA-ARS Fort Collins and Fargo breeding lines.

Entry		Identification	Disease Index[1] Aug. 30th	Sept. 7th	Sept. 14th
		$LSD_{0.05}$	**1.31**	**1.37**	**1.09**
LSS[2]	**(931002)**		**3.5**	**4.3**	**4.0**
LSR[3]	**(821051H2)**		**1.8**	**2.8**	**2.5**
Trial Mean			**1.8**	**2.6**	**3.0**
1715	99N0009-2	F1015/951013, F_3	1.5	3.3	3.0
1716	99N0009-3	F1015/951013, F_3	2.0	3.5	3.0
1717	99N0009-9	F1015/951013, F_3	1.8	3.0	3.3
1718	99N0009-11	F1015/951013, F_3	2.0	3.0	3.3
1719	99N0009-12	F1015/951013, F_3	1.8	3.3	3.3
1720	99N0009-13	F1015/951013, F_3	1.3	2.5	2.8
1721	99N0009-15	F1015/951013, F_3	1.0	2.0	3.0
1722	99N0009-16	F1015/951013, F_3	1.5	2.8	3.5
1723	99N0009-17	F1015/951013, F_3	2.0	2.8	3.3
1724	99N0009-19	F1015/951013, F_3	1.3	2.3	3.0
1725	99N0007	CIM	2.3	2.0	3.3
1726	99N0008	CJM	5.5	5.5	5.8
1727	99N0011	GW-359-M	2.3	3.0	3.3
1728	921022	FC702-7	1.5	2.5	3.0
1729	921021	FC703-5	1.0	2.0	2.8
1730	831085HO	FC708	1.3	2.3	2.5
1731	921024	FC709-2	1.5	2.0	3.0
1732	911026HO	FC715	1.5	2.8	2.5
1733	981025	FC717	1.8	3.0	3.0
1734	951017	FC727	1.5	3.0	3.0
1735	921025	FC728	2.0	3.3	3.3
1736	97A050	FC607	1.3	1.5	2.5

[1] Disease Index is based on a scale of 0 (=healthy) to 10 (=dead).
[2] The Leafspot Susceptible Check is SP351069-0.
[3] The Leafspot Resistant Check is ((FC504CMS x FC502/2) x SP6322-0).

Table 9. 2000 Curly Top Nursery in Kimberly, ID - USDA-ARS Fort Collins

Seed Number	Description	Mean 1st Rating 08/22/00	Mean 2nd Rating 09/06/00
96A008	**Resistant Check -- Beta G6040**	**4.0**	**5.0**
911032	**Susceptible Check – FC718**	**5.3**	**7.0**
20001003 -67	CTR/LSRmmpop – 981012aa x 981011-x	5.0	-
20001003 -71	CTR/LSRmmpop – 981012aa x 981011-x	4.0	-
20001003 -4	CTR/LSRmmpop – 981012aa x 981011-x	3.0	4.0
20001003 -53	CTR/LSRmmpop – 981012aa x 981011-x	4.0	5.0
20001003 -41	CTR/LSRmmpop – 981012aa x 981011-x	4.5	5.0
20001003 -31	CTR/LSRmmpop – 981012aa x 981011-x	4.3	5.0
20001003 -54	CTR/LSRmmpop – 981012aa x 981011-x	4.7	5.0
20001003 -9	CTR/LSRmmpop – 981012aa x 981011-x	4.7	5.5
20001003 -7	CTR/LSRmmpop – 981012aa x 981011-x	5.7	5.5
20001003 -12	CTR/LSRmmpop – 981012aa x 981011-x	5.3	5.5
20001003 -42	CTR/LSRmmpop – 981012aa x 981011-x	4.0	5.5
20001003 -15	CTR/LSRmmpop – 981012aa x 981011-x	4.5	5.5
20001003 -32	CTR/LSRmmpop – 981012aa x 981011-x	4.3	5.7
20001003 -40	CTR/LSRmmpop – 981012aa x 981011-x	4.7	5.7
20001003 -23	CTR/LSRmmpop – 981012aa x 981011-x	5.0	5.7
20001003 -24	CTR/LSRmmpop – 981012aa x 981011-x	6.0	5.7
20001003 -10	CTR/LSRmmpop – 981012aa x 981011-x	5.0	6.0
20001003 -5	CTR/LSRmmpop – 981012aa x 981011-x	4.5	6.0
20001003 -6	CTR/LSRmmpop – 981012aa x 981011-x	4.7	6.0
20001003 -19	CTR/LSRmmpop – 981012aa x 981011-x	4.7	6.0
20001003 -18	CTR/LSRmmpop – 981012aa x 981011-x	5.3	6.0
20001003 -21	CTR/LSRmmpop – 981012aa x 981011-x	5.3	6.0
20001003 -25	CTR/LSRmmpop – 981012aa x 981011-x	5.0	6.0
20001003 -78	CTR/LSRmmpop – 981012aa x 981011-x	5.0	6.0
20001003 -3	CTR/LSRmmpop – 981012aa x 981011-x	4.5	6.0
20001003 -14	CTR/LSRmmpop – 981012aa x 981011-x	5.5	6.0
20001003 -30	CTR/LSRmmpop – 981012aa x 981011-x	5.0	6.0
20001003 -64	CTR/LSRmmpop – 981012aa x 981011-x	5.0	6.0
20001003 -50	CTR/LSRmmpop – 981012aa x 981011-x	5.3	6.0
20001003 -58	CTR/LSRmmpop – 981012aa x 981011-x	5.0	6.0
20001003 -55	CTR/LSRmmpop – 981012aa x 981011-x	5.0	6.0
20001003 -36	CTR/LSRmmpop – 981012aa x 981011-x	4.7	6.0
20001003 -37	CTR/LSRmmpop – 981012aa x 981011-x	5.0	6.0
20001003 -76	CTR/LSRmmpop – 981012aa x 981011-x	4.5	6.0
20001003 -62	CTR/LSRmmpop – 981012aa x 981011-x	4.3	6.0
20001003 -68	CTR/LSRmmpop – 981012aa x 981011-x	5.0	6.0
20001003 -79	CTR/LSRmmpop – 981012aa x 981011-x	4.7	6.5
20001003 -39	CTR/LSRmmpop – 981012aa x 981011-x	5.0	6.5
20001003 -86	CTR/LSRmmpop – 981012aa x 981011-x	5.0	6.5
20001003 -44	CTR/LSRmmpop – 981012aa x 981011-x	5.0	6.5
20001003 -85	CTR/LSRmmpop – 981012aa x 981011-x	5.7	6.5
20001003 -13	CTR/LSRmmpop – 981012aa x 981011-x	5.5	6.5
20001003 -65	CTR/LSRmmpop – 981012aa x 981011-x	5.3	6.5
20001003 -29	CTR/LSRmmpop – 981012aa x 981011-x	5.0	6.5
20001003 -59	CTR/LSRmmpop – 981012aa x 981011-x	4.7	6.5
20001003 -66	CTR/LSRmmpop – 981012aa x 981011-x	5.3	6.5
20001003 -56	CTR/LSRmmpop – 981012aa x 981011-x	5.7	6.5
20001003 -27	CTR/LSRmmpop – 981012aa x 981011-x	5.7	7.0
20001003 -52	CTR/LSRmmpop – 981012aa x 981011-x	5.7	7.0
20001003 -35	CTR/LSRmmpop – 981012aa x 981011-x	5.3	7.0

Table 9. 2000 Curly Top Nursery in Kimberly, ID - USDA-ARS Fort Collins			
		Mean	
		1st Rating	2nd Rating
Seed Number	Description	08/22/00	09/06/00
96A008	**Resistant Check – Beta G6040**	**4.0**	**5.0**
911032	**Susceptible Check – FC718**	**5.3**	**7.0**
20001003 -38	CTR/LSRmmpop – 981012aa x 981011-x	5.3	7.0
20001003 -49	CTR/LSRmmpop – 981012aa x 981011-x	5.3	7.0
20001003 -8	CTR/LSRmmpop – 981012aa x 981011-x	6.0	7.0
20001003 -28	CTR/LSRmmpop – 981012aa x 981011-x	5.5	7.0
20001003 -22	CTR/LSRmmpop – 981012aa x 981011-x	5.3	7.0
20001003 -11	CTR/LSRmmpop – 981012aa x 981011-x	6.3	7.0
20001003 -61	CTR/LSRmmpop – 981012aa x 981011-x	4.7	7.0
20001003 -48	CTR/LSRmmpop – 981012aa x 981011-x	6.7	7.0
20001003 -57	CTR/LSRmmpop – 981012aa x 981011-x	5.0	7.0
20001003 -74	CTR/LSRmmpop – 981012aa x 981011-x	5.0	7.0
20001003 -81	CTR/LSRmmpop – 981012aa x 981011-x	5.3	7.0
20001003 -72	CTR/LSRmmpop – 981012aa x 981011-x	5.7	7.0
20001003 -46	CTR/LSRmmpop – 981012aa x 981011-x	6.3	7.5
20001003 -47	CTR/LSRmmpop – 981012aa x 981011-x	5.7	7.5
20001003 -51	CTR/LSRmmpop – 981012aa x 981011-x	5.3	7.5
20001003 -60	CTR/LSRmmpop – 981012aa x 981011-x	5.7	7.5
20001003 -77	CTR/LSRmmpop – 981012aa x 981011-x	5.7	7.5
20001003 -26	CTR/LSRmmpop – 981012aa x 981011-x	6.0	7.5
20001003 -16	CTR/LSRmmpop – 981012aa x 981011-x	6.0	7.5
20001003 -17	CTR/LSRmmpop – 981012aa x 981011-x	5.7	7.5
20001003 -84	CTR/LSRmmpop – 981012aa x 981011-x	5.0	7.5
20001003 -63	CTR/LSRmmpop – 981012aa x 981011-x	5.0	8.0
20001003 -75	CTR/LSRmmpop – 981012aa x 981011-x	5.0	8.0
20001003 -80	CTR/LSRmmpop – 981012aa x 981011-x	6.0	8.0
20001003 -73	CTR/LSRmmpop – 981012aa x 981011-x	6.3	8.0
20001003 -83	CTR/LSRmmpop – 981012aa x 981011-x	5.7	8.0
20001003 -43	CTR/LSRmmpop – 981012aa x 981011-x	6.0	8.0
20001003 -45	CTR/LSRmmpop – 981012aa x 981011-x	6.0	8.0
20001003 -87	CTR/LSRmmpop – 981012aa x 981011-x	5.5	8.0
20001003 -20	CTR/LSRmmpop – 981012aa x 981011-x	6.3	8.5
20001003 -70	CTR/LSRmmpop – 981012aa x 981011-x	-	9.0
20001005 -3	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	-	-
20001005 -4	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	-	-
20001005 -8	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	-	-
20001005 -19	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.0	-
20001005 -25	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	-	-
20001005 -33	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	-	-
20001005 -37	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.0	-
20001005 -43	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	-	-
20001005 -50	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	4.0	-
20001005 -63	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	-	-
20001005 -76	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.0	-
20001005 -90	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	-	-
20001005 -99	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	-	-
20001005 -109	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	-	-
20001005 -111	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.0	-
20001005 -113	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.0	-
20001005 -133	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	-	-
20001005 -136	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.0	-
20001005 -78	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	4.5	6.0

Table 9. 2000 Curly Top Nursery in Kimberly, ID - USDA-ARS Fort Collins		Mean	
		1st Rating	2nd Rating
Seed Number	**Description**	**08/22/00**	**09/06/00**
96A008	**Resistant Check – Beta G6040**	**4.0**	**5.0**
911032	**Susceptible Check – FC718**	**5.3**	**7.0**
20001005 -65	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.0	6.5
20001005 -116	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	4.5	6.5
20001005 -95	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.5	7.0
20001005 -62	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.0	7.0
20001005 -79	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.0	7.0
20001005 -143	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.0	7.0
20001005 -17	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	4.0	7.0
20001005 -11	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.7	7.0
20001005 -22	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.0	7.0
20001005 -126	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.0	7.5
20001005 -56	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.3	7.5
20001005 -110	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.0	7.5
20001005 -120	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.0	7.5
20001005 -135	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.0	7.5
20001005 -60	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.3	7.5
20001005 -2	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.5	7.5
20001005 -40	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.0	8.0
20001005 -38	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.0	8.0
20001005 -46	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.0	8.0
20001005 -12	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.5	8.0
20001005 -13	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	8.0	8.0
20001005 -42	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.5	8.0
20001005 -9	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.0	8.0
20001005 -14	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.5	8.0
20001005 -49	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.0	8.0
20001005 -36	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.0	8.0
20001005 -96	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.0	8.0
20001005 -72	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.0	8.0
20001005 -130	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.0	8.0
20001005 -129	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.5	8.0
20001005 -128	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.7	8.0
20001005 -119	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.5	8.0
20001005 -104	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.0	8.0
20001005 -71	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.0	8.0
20001005 -88	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.5	8.0
20001005 -77	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.3	8.0
20001005 -150	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.0	8.0
20001005 -101	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.7	8.0
20001005 -94	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.0	8.0
20001005 -83	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.7	8.5
20001005 -47	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.7	8.5
20001005 -48	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.3	8.5
20001005 -10	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.3	8.5
20001005 -103	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.7	8.5
20001005 -16	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.0	8.5
20001005 -92	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.3	8.5
20001005 -20	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.7	8.5
20001005 -115	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.3	8.5
20001005 -23	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.0	8.5
20001005 -15	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.7	8.5

Table 9. 2000 Curly Top Nursery in Kimberly, ID - USDA-ARS Fort Collins

Seed Number	Description	Mean 1st Rating 08/22/00	Mean 2nd Rating 09/06/00
96A008	**Resistant Check -- Beta G6040**	**4.0**	**5.0**
911032	**Susceptible Check – FC718**	**5.3**	**7.0**
20001005 -114	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.3	8.5
20001005 -98	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	8.0	9.0
20001005 -82	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.5	9.0
20001005 -58	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.5	9.0
20001005 -32	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	8.0	9.0
20001005 -35	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.3	9.0
20001005 -93	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	8.0	9.0
20001005 -100	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	13.5	9.0
20001005 -24	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	5.5	9.0
20001005 -86	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	8.0	9.0
20001005 -21	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.3	9.0
20001005 -39	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.0	9.0
20001005 -45	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.0	9.0
20001005 -68	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.0	9.0
20001005 -51	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.5	9.0
20001005 -18	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.5	9.0
20001005 -125	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.7	9.0
20001005 -87	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.0	9.0
20001005 -52	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	8.0	9.0
20001005 -54	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.3	9.0
20001005 -55	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	8.0	9.0
20001005 -31	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	8.0	9.0
20001005 -97	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.7	9.0
20001005 -57	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	7.0	9.0
20001005 -5	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	6.7	9.0
20001005 -7	SucroseMM x LSRMM Fargo – (971001Hrr x 961001R-)F2	9.0	9.0
991003H		5.0	-
911043HO	FC403	4.5	4.5
911043HO1	FC403CMS	4.3	4.5
991003H		5.5	5.0
97A050	FC607	5.5	5.0
981032		5.3	5.5
981009H		5.0	6.0
991003H2		5.3	6.0
991003H2		5.3	7.0
20001002	(FC907 x FC709-2)F3-sel (981009H)	5.3	7.0
991002PF		5.0	7.5
991002PF		5.0	7.5
20001004	LSR/CTRMM x LSRFargo (981036)	5.5	7.5
981011H		5.7	7.5
20001006	LSR(4x) x Sucrose(4X)	5.3	8.0
981037		7.0	8.0
951016HO	FC723	6.5	8.0
981035		6.7	8.0
971017	FC710 (4X)	7.0	8.0
961011HO	FC607/FC708	7.0	8.0
991030MS		5.5	8.0
961011HO1	FC607/FC708CMS	7.7	8.5
951014	(2890aa & 2859aa) x FC708	6.7	8.5
951016HO1	FC723CMS	7.0	8.5

Table 9. 2000 Curly Top Nursery in Kimberly, ID - USDA-ARS Fort Collins			
		Mean	
		1st Rating	2nd Rating
Seed Number	Description	08/22/00	09/06/00
96A008	**Resistant Check – Beta G6040**	**4.0**	**5.0**
911032	**Susceptible Check – FC718**	**5.3**	**7.0**
991031PF		6.0	8.5
991018	FC709-2	7.7	8.5
991026MS		6.3	8.5
991016		7.3	8.5
971020	FC907-1	7.0	8.5
961010HO	FC722-1	9.0	9.0
961010HO1	FC722CMS	9.0	9.0
961012HO1	FC712/MonoHy A4 - CMS equivalent	7.7	9.0
961012HO	FC712/MonoHy A4	8.3	9.0
961013HO	FC506	8.0	9.0
971018	FC712 (4X)	8.0	9.0
911026HO	FC715	6.5	9.0
991026PF		7.0	9.0
991019	FC711	7.7	9.0
831085HO	FC708	8.5	9.0
991032MS		7.0	9.0
961015	FC720-1	8.0	9.0
951017	FC727	8.3	9.0

PRE-BREEDING: THE INTROGRESSION OF NEW SOURCES OF CERCOSPORA LEAF SPOT RESISTANCE FROM *BETA VULGARIS* SPP. *MARITIMA* AND OTHER EXOTIC SOURCES INTO SUGAR BEET-TYPE POPULATIONS. (BSDF Project 443)

L. Panella

A major emphasis of the research mission of the USDA-ARS plant scientists is the collection, documentation, characterization, evaluation, regeneration (maintenance), distribution, and utilization of plant germplasm, especially Plant Introduction (PI) accessions in the USDA-ARS National Plant Germplasm System (NPGS). The Sugar Beet Research Unit at Fort Collins is coordinating the national program for *Beta* germplasm evaluation. In addition to the evaluation for Rhizoctonia and Cercospora resistance, it is crucial that the ARS scientist be involved in the long rang, high risk research problems involved in sugar beet 'germplasm enhancement' or 'pre-breeding' from exotic germplasm or wild relatives. This is an important component in the overall sugar beet improvement effort of the Fort Collins Sugar Beet Research Unit.

Justification for Research: Cercospora leaf spot (caused by the fungus *Cercospora beticola* Sacc.) is one of the most widespread diseases of sugar beet and is a serious problem in many sugar beet production areas throughout the U.S. The disease damages the leaves, which, consequently, reduces root yield, percent sucrose of roots, and purity of the extracted juice. Cercospora leaf spot currently is controlled by combining spraying with commercial fungicides and the use of disease tolerant germplasm. The development of Cercospora leaf spot resistant sugar beet lines and hybrids with greater levels of host-plant resistance offers a more sustainable solution to this disease problem.

If the level of resistance available in some Cercospora-resistant experimental breeding lines were present in commercial hybrids (**along with good sugar and seed yield**), the need for fungicides could be greatly reduced. That continued improvement in genetic resistance to this serious pathogen is still needed is evident by the occurrence of *Cercospora* strains that are tolerant to our most potent fungicides. Additionally, some fungicides may be removed from the market because of their perceived or real threat to the environment.

Finally, the genepool for resistance to Cercospora leaf spot is extremely narrow. Many of the resistant lines are highly inbred, therefore, closely related to one another, and stem from germplasm coming out of Italy in the early 1900s. In the germplasm developed at Fort Collins, continued inbreeding has increased the level of disease resistance, but at the cost of plant vigor. Over the long term, a secure, sustainable response to this disease requires commercial quality hybrids with good host-plant resistance.

Objectives:

1. The formation of long range breeding populations through the introgression of Cercospora resistant germplasm from "exotic" sources (*Beta vulgaris* spp. *maritima*, fodder beet, foreign sugar beet landraces from the PI collection, etc.).

2. The development of germplasm populations from these long range populations that are of sufficient agronomic quality to be of use to commercial breeders. They will be a source of leaf spot resistance with and within differing genetic backgrounds.

3. The development of techniques (both traditional and molecular) to more efficiently introgress the exotic germplasm into sugar beet breeding populations.

Research Progress 2000:

Crosses have been made or are being attempted in the greenhouse on the list of accession below, all of which have been identified as having Cercospora resistance. F_2 populations are being planted from the F_1 populations, and F_3 populations from the F_2, where possible (See table below). F_2 seed of three crosses (96A011, 96A015, and 96A016 as donor parents) has been bulk increased in the greenhouse and this is being planted to produce F_3 populations. All three show some biennial plants in our environment because they were crossed to genetic male sterile (*aa*) sugar beets. These F_1 increases should be completed by the beginning of 2002. We are considering re-crossing some of those from which we obtained insufficient F_1 seed, but will concentrate primarily with those populations from which we have sufficient seed.

Plants from those populations producing some biennial plants are being vernalized for 90 days and the populations are being increased (i.e., random mated using the genetic male sterility where possible). The annuals will be handled in a similar fashion once the F_1 populations have been increased. All will be cycled through at least three cycles of random mating.

The most advanced populations are being screened for resistance to Cercospora leaf spot (981032, 991026MS, and 991026PF) and curly top. All three showed good resistance to Cercospora leaf spot, and 981032 showed resistance comparable to a commercial control in the curly top nursery (Tables 7 and 9). All of the populations are still segregating for biennial growth habit and many other wild traits.

Development of a resistant germplasm line generally takes seven years. A longer time will be necessary to incorporate disease resistance from more exotic sources. Because this is a new program it will take time for the first germplasm to make it through the process. Once that happens, there will be a "pipeline" of germplasm in various stages of development and the release of new germplasm will occur every two to four years. The incorporation of exotic sources into agronomically acceptable germplasm is a long term proposition - results will not appear overnight. This is the type of long-term, high risk germplasm research that ARS is well-suited to perform.

Materials and Methods:

Artificial field inoculation with *Cercospora beticola* and leaf spot scoring will be used to identify the resistant germplasm sources and make selections in the developing populations. The exotic materials will be crossed into sugar beet populations that have been selected for agronomic quality (recoverable sucrose yield). These are currently under development using germplasm received from commercial breeding programs, public sources (e.g., L19), and some high sucrose germplasm from Poland. These sugar beet populations will be self-fertile (S^f) and segregating for nuclear male sterility (*A-:aa*). Populations will be handled in the following manner: 1) Following the initial cross, a population will be random mated (using *aa* females because of the self-fertility) for three to four generations to break up linkage groups and remove annual plants. 2) Sugar beet-type mother roots will be selected, selfed, and progeny tested for agronomic performance and disease resistance. 3) Selected roots will be recombined (and backcrossed if desirable) and re-selected until they ready for release. Molecular markers (RFLPs, RAPDs, SSRs, AFLPs, etc.) as they become available will be used to expedite the backcrossing program and to follow the change in allele frequencies in the selected populations. Advanced populations will be released to the sugar beet seed industry.

List of exotic Cercospora beticola resistant germplasm being used in the USDA-ARS Fort Collins breeding program.

Accession Number	Donor Designation	Name or Origin	% Bolting without induction 1996 Fort Collins	F_1 Population	F_2 Population	F_3 Population
96A010	PI 535826	Giant Poly	20%	971021H2	981031	991026
96A011	PI 535833	Saturn	0%	unsuccessful		
96A014	PI 540593	WB 847	0%	971023H2		
96A015	PI 540596	WB 850	70%	971024H2	981032	
96A017	PI 540605	WB 859	25%	971025H2		
96A012	PI 535843	PN MONO 1	100%	971026H2[1]		
96A013	PI 540575	WB 829	100%	971027H2[2]		
96A016	PI 540599	WB 853	50%	971028H2	981033	
94A079	IDBB #32375 (*B. v.* ssp. *maritima*)	Greece	annual	971029H2		
94A080	IDBB #36538 (*B. v.* ssp. *maritima*)	Greece	annual	971030H2[3]		
94A081	IDBB #45511 (*B. v.* ssp. *maritima*)	Greece	annual	981001H3		
94A082	*IDBB* #45516 (*B. v.* ssp. *maritima*)	Greece	annual	981002H2		
94A083	IDBB #48810 (*B. v.* ssp. *maritima*)	Tunisia	annual	981003H2		
94A084	IDBB #48819 (*B. v.* ssp. *maritima*)	Tunisia	annual	981004H3		
94A085	IDBB #51430 (*B. v.* ssp. *maritima*)	Greece	annual	981005H3		

[1]Only 16 seed balls produced.
[2]Only 10 seed balls produced.
[3]Only 60 seed balls produced.

Summary of Literature: Cercospora leaf spot has been an intermittent problem in sugar beet growing areas of the United States where the summers can be hot and humid (Red River Valley, Michigan, Ohio, and, less often, Great Plains growing areas and California). It has been estimated that a severe epidemic can cause up to a 42% loss of gross sugar (Smith and Martin, 1978; Smith and Ruppel, 1973), or up to a 43% relative dollar loss (Shane and Teng, 1992).

Resistance to Cercospora leaf spot has long been a goal of the USDA-ARS sugar beet research program at Fort Collins and researchers there developed the techniques necessary to manage the screening nurseries in such a way as to promote the development of the disease (Ruppel and Gaskill, 1971). A careful crop rotation (sugar beet-barley-barley-barley-sugar beet) and the arid climate and low relative humidity have allowed this to be done in such a manner that there are rarely high enough levels of any other disease present in the leaf spot nursery to confound the results.

There are an estimated 4 or 5 genes responsible for *Cercospora* resistance (Smith and Gaskill, 1970) and broad-sense heritability estimates ranged from 12 to 71% (Bilgen et al., 1969). Narrow-sense heritability estimates of about 24% compared well with realized heritability values, and 44 to 62% of the variation was due environment in this test (Smith and Ruppel, 1974). The large environmental variation has made it difficult to make progress in developing *Cercospora* resistance through mass selection. Incorporation of high levels of leaf spot resistance into varieties with superior agronomic performance also is difficult (Smith and Campbell, 1996) and, therefore, commercial resistant varieties require some fungicide application to provide adequate levels of protection against Cercospora (Miller et al., 1994).

A major problem in the development of *Cercospora*-resistant sugar beet is the loss of vigor due to the continual inbreeding. Coons (1955) noted this and it has been a concern ever since (McFarlane, 1971). The use of hybrid varieties has ameliorated this problem to some extent, but seed production on the highly inbred O-type males and CMS females still is a problem. This is seen in germplasm from both the FC 500 and FC 600 series developed at Fort Collins.

The USDA-ARS National Plant Germplasm System *Beta* collection has over 2,000 Plant Introduction (PI) accessions. The germplasm used most often in sugar beet breeding is from *Beta vulgaris* spp. *vulgaris*, which includes all of the biennial sugar beet types, or from *Beta vulgaris* spp. *maritima*, which contains the closely related wild sea beet and has both annual and biennial types. Germplasm with a biennial flowering habit is easier both to introgress and screen. *Beta vulgaris* spp. *maritima* has, nonetheless, been used as a source of resistant germplasm. Much of the *Cercospora*-resistant germplasm in use today came out of Munerati's program in Italy, in which *B. vulgaris* spp. *maritima* was the source of resistance genes (Lewellen, 1992). There have been very few new efforts to locate and incorporate other sources of resistance to *Cercospora* into this narrow germplasm base.

There is an urgent need to continue to create in our *Cercospora*-resistant germplasm a broader genetic base than we have today. As commercial hybrid parents become more inbred, the germplasm base from which these inbred parents are developed must have the diversity necessary to provide for maximum gain through heterosis. Munerati's success, and the research of others, has shown that it can be done if we have the persistence to do it (Bilgen et al., 1969; Doney, 1993; Lewellen, 1995).

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DEVELOPMENT AND TESTING OF SUGAR BEET CYST NEMATODE RESISTANT GERMPLASM (BSDF Project 446)

Lee Panella, Saad Hafez and Bob Lewellen

Justification for Research:

The sugar beet cyst nematode (SBCN) (*Heterodera schachtii*, Schmidt) is one of the most serious pests of sugar beet (*Beta vulgaris* L. subsp. *vulgaris*) throughout the western United States and many other parts of the world where sugar beet is cultivated. Nematode infested fields will first look wilted and as the stress grows, the sugar beet plants are underdeveloped and chlorotic. The root tip is destroyed and the main tap root deformed. Secondary roots proliferate from the tap root in the upper soil profile giving the root a beard-like appearance (sometimes confused with Rhizomania) and diminishing the ability of the plant to absorb water from deeper in the soil profile. The yellow and brown females (cysts) can be found on these secondary roots.

The damage is caused by the nematode destroying the tap root, diminishing the ability of the plant to absorb water, and feeding on the plant cytoplasm in the infested root cells. In heavily infested fields, crop yields can be depressed by up to 80%. Current management systems rely on Telone II™, Temik™, or other nematicides. These nematicides/fumigants have been removed from the market in some states and are in danger of being removed in others because of their perceived or real threat to the environment.

There have been no SBCN resistant varieties released in the U.S. market. Most SBCN resistant commercial varieties or those near commercialization rely on the resistance transferred from the section Procumbentes species. The introgression of this resistance gene was through a translocation that happened in a monosomic addition line. There is still a linkage drag associated with these lines that keep there yield between 10 and 15% less than high performing commercial lines.

Screening of the USDA-ARS National Plant Germplasm System's (NPGS) *Beta* collection in 1998 and 1999 for resistance to SBCN showed 5 potential accessions with varied degrees of resistance to SBCN. On a 0 to 9 scale (with 0 being immune), one accession was rated as 3 and four accessions were rated as 4 (See Appendices 1 & 2). The experimental design was randomized block with five replications and there were differences among the plants making up the replications. Again in this year's Sugar Beet CGC coordinated evaluations, two accessions were rated as 2 and two accessions were rated as 4.

Research Progress 2000:

Four sugar beet accessions, which had shown some promise for SBCN resistance were sent to Dr. Hafez (U of I, Parma, ID) for evaluation. Fifty plants each of PI 142808, PI 518809, PI 232894, PI 357354 were planted for evaluation (See Appendices 1). Germination was poor in PI 142808 and it was being replanted. The most resistant parents were sent to Fort Collins as stecklings, where the crossing and seed production is being done. We will be using plants that had no cysts on the roots after screening and no viable cysts in the soil. Appropriate vernalization will be performed on the accessions all of which are biennial. Three more parents will be screened and resistant progeny crossed PI 546455 (*Beta macrocarpa*), PI 518303 (*B. v.* subsp. *maritima*) and PI546413 (*B. v.* subsp. *maritima* – WB242) Both biennial and annual donor parents will be crossed to a Rhizomania resistant, male sterile (*aa*), self-fertile female line, 9933 or 0931(provided by R. T. Lewellen). A

branch of each donor plant will be selfed to determine if the plants are self-incompatible. The crosses will be in bulked with each accession kept isolated from the others. Some controlled pair crossing will be done to provide material for genetic analyses.

Summary of Literature Review:

The sugar beet cyst nematode (SBCN) (*Heterodera schachtii*, Schmidt) is one of the most serious pests of sugar beet (*Beta vulgaris* L. subsp. *vulgaris*). It was identified in Germany in the mid 1800s and observed in the US by 1895. It has been reported to be in 17 states throughout the United States (Hafez, 1998, 1999) and in 39 countries where sugar beet is cultivated (Gray et al., 1992). In these areas 10 - 25% of the acreage is infested (Lange and De Bock, 1994). This pest is hosted by over 80% of the species in the *Chenopodiaceae* and *Brassicaceae* families (Steele, 1965; Hafez and Sundararaj, 1998, 1999). Accessions from all four sections of the genus *Beta* have been screened for host plant resistance. No good source of host plant resistance has been found in *Beta vulgaris* subsp. *vulgaris*. All of the species in *Beta* section Procumbentes have shown immunity to the SBCN and there has been a great effort to transfer this immunity to sugar beet (reviewed by Van Geyt et al. (1990)). Because of problems with transmission of the introgressed genes and linked deleterious genes, more molecular approaches have been tried, culminating with the cloning of the $Hs1^{pro\text{-}1}$ gene (Cai et al., 1997). Finally, although there are commercial varieties with the *Procumbentes* source of resistance close to market, there is a concern that the resistance will not be durable. That this resistance can be overcome or at least weakened has been experimentally shown (Lange et al., 1993), and there is concern that this will also be the case when varieties carrying this resistance are widely deployed in the field.

A second source of resistance has been reported from *Beta vulgaris* subsp. *maritima*, which was collected in France. Heijbroek (1977) reported that this material was partially resistant and that the resistance was most probably recessive. This material was transferred to the Foundation for Agricultural Plant Breeding in Wageningen, the Netherlands put into a breeding program. Lange and De Bock (1994) reported that the host plant resistance seen in this sugar beet population was a type of reduced susceptibility that reduced the number and size of cysts produced on its roots. The recessive, polygenic control of this host plant resistance has made plant breeders reluctant to use it in commercial breeding programs.

The USDA-ARS National Plant Germplasm System *Beta* collection has over 2,000 Plant Introduction (PI) accessions. The Sugar Beet Crop Germplasm Committee has had an aggressive evaluation program in place since 1985 (Panella et al., 1998). The germplasm used most often in sugar beet breeding is from *Beta vulgaris* spp. *vulgaris*, which includes all of the biennial sugar beet types, and this material has had the first priority in screening. *Beta vulgaris* spp. *maritima*, which contains the closely related wild sea beet and has both annual and biennial types currently is being screened, and a few potentially SBCN resistant accessions have been identified by Dr. Saad Hafez. Germplasm with a biennial flowering habit is easier to introgress but annual *Beta vulgaris* spp. *maritima*, nonetheless, has been used as a source of resistant germplasm in other resistance breeding programs, and the research of others has shown that it can be done if we have the persistence to do it (Bilgen et al., 1969; Doney, 1993; Lewellen, 1995).

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Objectives:

1. The formation of long range breeding populations through the introgression of Sugar Beet Cyst Nematode resistant germplasm from "exotic" sources (*Beta vulgaris* spp. *maritima*, fodder beet, foreign sugar beet landraces from the PI collection, etc.).

2. The development of germplasm populations from these long range populations that are of sufficient agronomic quality to be of use to commercial breeders. They will be from differing sources of SBCN resistance with different genetic backgrounds – a present it is impossible to tell whether or not the genes responsible for the resistance are different in the different sources.

3. The development of techniques (both traditional and molecular) to more efficiently introgress the exotic germplasm into sugar beet breeding populations.

Materials and Methods:

Sugar beet seeds have been planted in the greenhouse in conetainers® containing naturally infested beet cyst nematode soil (5.3 eggs and larvae per 1 cm^3 soil). The accessions were compared to the susceptible check, HM WSPM9 and a resistant *B. v.* subsp. *maritima* check. Sugar beet seedlings were separated from soil eight weeks after planting. Mature SBCN females and cysts were counted from the roots and soil. Seven accessions were chosen on the base of their resistance (scored 0 through 9 with 0 most resistant) and taxonomic and geographic differences. Fifty seedlings of each accession were screened and the best performing plants used as SBCN-resistant parents. The screening was done in Parma, ID by Dr. Saad Hafez who has worked with the Sugar Beet CGC to screen the USDA-ARS NPGS's *Beta* collection.

The most resistant parents were sent to Fort Collins, where the crossing and seed production is being done. Appropriate vernalization will be performed on the biennial accessions. Both biennial and annual donor parents will be crossed to a Rhizomania resistant, male sterile (*aa*), self-fertile female line (provided by R. T. Lewellen). A branch of each donor plant will be selfed to determine if the plants are self-incompatible. The crosses will be in bulk with each accession kept isolated from the others. Some controlled pair crossing will be done to provide material for genetic analyses.

Some of the F_1 hybrids will be screened in the Greenhouse for SBCN resistance and they will be bulk increased to provide F_2 plants for evaluation. Populations will be random mated (using *aa* females because of the self-fertility) to break up linkage groups and remove annual plants while being evaluated and selected. Selected roots will be recombined (and backcrossed if desirable) and re-selected until they ready for release. Molecular markers (RFLPs, RAPDs, SSRs, AFLPs, etc.) as they become available will be used when possible to expedite the backcrossing program and to follow the change in allele frequencies in the selected populations. Advanced populations will be released to the sugar beet seed industry.

Appendix 1

1998 CGC Evaluations of NPGS PIs for Resistance to Sugar Beet Cyst Nematode

S. Hafez, M. Larkin, R. Portenier and K. Hara, University of Idaho, Parma, ID 83660

Thirty sugar beet (*Beta vulgaris*) PI Accessions were evaluated for resistance to the beet cyst nematode (*Heterodera schachtii*) in 1998. Sugar beet seeds were planted 12 May in the greenhouse in 500 cm^3 pots containing naturally infested beet cyst nematode soil (5.3 eggs and larvae per 1 cm^3 soil). The PI accessions were compared to the susceptible check, HM WSPM9. Experimental design was randomized block with five replications. Sugar beet seedlings were separated from soil eight weeks after planting (09 Jul). Beet cyst nematode females and cysts were enumerated from the roots and soil. An analysis of variance was performed on the data, and mean separation was computed using the least significant difference. A numeric score of 0 to 9 was assigned to each PI accession (0 = immune, 9 = highly susceptible).

Beet Cyst Nematode (females & cyst count) data and analysis from 1998 test.

PI Accession	Roots		Soil		Total		Score[1]
NSL 81098	45	abcdefg	342	a	387	a	9
PI 386209	55	abc	319	ab	374	ab	9
PI 386206	44	abcdefg	307	abc	351	abc	9
HM WSPM9	52	abcd	286	abcd	338	abcd	9
NSL 93279	30	cdefgh	285	abcd	315	abcde	9
PI 232892	33	bcdefgh	270	abcde	303	abcde	8
PI 491195	50	abcde	241	abcdef	291	abcdef	8
PI 357359	67	a	221	bcdefg	288	abcdef	8
PI 486360	34	bcdefgh	249	abcde	283	abcdefg	8
PI 355961	46	abcdef	227	abcdefg	273	abcdefgh	8
PI 264152	47	abcdef	226	abcdefg	273	abcdefgh	8
PI 286501	59	ab	212	bcdefg	271	abcdefgh	8
PI 285592	38	bcdefgh	232	abcdefg	270	abcdefgh	8
PI 535839	44	abcdefg	209	bcdefg	253	bcdefghi	7
PI 490993	51	abcde	200	cdefg	251	bcdefghi	7
PI 142815	47	abcdef	193	cdefg	240	cdefghi	7
PI 486356	59	ab	177	defg	236	cdefghi	7
NSL 80223	45	abcdef	186	defg	231	cdefghi	6
PI 263865	42	abcdefgh	188	defg	230	cdefghi	6
PI 368376	48	abcde	182	defg	230	cdefghi	6
PI 286502	24	efgh	202	bcdefg	226	cdefghi	6
PI 269309	43	abcdefg	177	defg	220	defghi	6
PI 142813	29	cdefgh	187	defg	216	defghi	6
NSL 93277	19	fgh	193	cdefg	212	defghi	6
NSL 95217	27	defgh	183	defg	210	defghi	6
PI 357357	46	abcdef	157	efg	203	efghi	6
PI 357354	31	cdefgh	131	fg	162	fghi	4
PI 232894	34	bcdefgh	120	g	154	ghi	4
PI 142809	30	cdefgh	120	g	150	hi	4
PI 507849	17	gh	122	g	139	i	4
PI 142808	14	i	117	g	131	i	3
LSD (0.05)	28		117		130		

[1] Score: 0 = immune, 9 = highly susceptible to beet cyst nematode.

Appendix 2

1999 CGC Evaluations of NPGS PIs for Resistance to Sugar Beet Cyst Nematode

S. Hafez, M. Larkin, R. Portenier and K. Hara – University of Idaho, Parma, ID 83660

EVALUATION OF THIRTY SUGAR BEET (*Beta vulgaris*) PI ACCESSIONS FOR RESISTANCE TO BEET CYST NEMATODE (*Heterodera schachtii*), 1999: Sugar beet seeds were planted 03 May in the greenhouse in 500 cm^3 pots containing naturally infested beet cyst nematode soil (4.3 eggs and larvae per 1 cm^3 soil). Thirty PI accessions were compared to the susceptible check, HM WSPM9. Experimental design was randomized block with six replications. Sugar beet seedlings were separated from soil ten weeks after planting (13 Jul). Beet cyst nematode females and cysts were enumerated from the roots and soil. An analysis of variance was performed on the data, and mean separation was computed using the least significant difference. A numeric score of 0 to 9 was assigned to each PI accession (0 = immune, 9 = highly susceptible).

PI Accession	Beet Cyst Nematode (females & cyst count)						Score[1]
	Roots		Soil		Total		
PI 116808	22	cd	316	a	338	a	9
PI 546396	43	a	270	ab	313	ab	9
PI 179176	35	ab	248	abc	283	abc	9
PI 174060	16	cdefgh	260	ab	276	abc	9
PI 172734	18	cdefg	254	ab	272	abc	9
PI 172730	7	efghi	265	ab	272	abcd	9
PI 173841	8	defghi	244	abcd	252	abcde	9
PI 271441	19	cdef	225	abcde	244	abcdef	9
Ames 8300	24	bc	216	abcdef	240	abcdef	9
PI 173843	18	cdefg	210	abcdef	229	abcdefg	9
PI 164172	12	cdefghi	215	abcdef	227	abcdefg	9
PI 215577	20	cde	200	bcdef	220	bcdefg	9
PI 504173	19	cdef	200	bcdef	219	bcdefg	9
PI 120701	9	defghi	196	bcdefg	205	bcdefgh	9
PI 268365	12	cdefghi	193	bcdefg	205	bcdefgh	9
PI 193458	10	cdefghi	188	bcdefgh	198	bcdefghi	9
PI 120690	9	defghi	186	bcdefgh	195	cdefghi	9
HM WSPM9 (susceptible check)	12	cdefghi	182	bcdefgh	194	cdefghi	9
PI 169020	9	defghi	180	bcdefgh	189	cdefghi	9
PI 142810	6	fghi	171	bcdefgh	177	cdefghi	9
PI 277270	12	cdefghi	143	cdefghi	155	defghij	8
PI 486357	4	hi	142	cdefghi	146	efghij	7
PI 442069	7	efghi	139	cdefghi	146	efghij	7
NSL 93284	3	hi	138	defghi	141	efghij	7
PI 546534	8	efghi	132	efghi	140	efghij	7
NSL 95218	2	i	133	efghi	135	fghij	6
PI 504199	5	ghi	108	fghi	113	ghij	5
PI 257280	9	defghi	88	ghi	97	hij	4
PI 504180	6	fghi	79	hi	85	ij	4
PI 518303	1	i	55	i	56	j	2
PI 546455	0	i	50	i	50	j	2
LSD (0.05)	14		110		117		

[1] Score: 0 = immune, 9 = highly susceptible to beet cyst nematode.

SUGAR BEET RESEARCH

2000 REPORT

Section C

U.S.D.A., A.R.S., Western Regional Plant Introduction Station
Pullman, Washington

Dr. Alan Hodgdon, *Beta* Curator

This research was supported in part by funds provided through the
Beet Sugar Development Foundation (Project 290)

CONTENTS

Status report on the *Beta* germplasm collection activities at the USDA, ARS, Western Regional Plant Introduction Station To the Beet Sugar Development Foundation Curator: Dr. Alan Hodgdon, 2001

This report is on the activity of the *Beta* germplasm collection at the Western Regional Plant Introduction Station (WRPIS), Pullman, WA. Fifty-four accessions were increased at WRPIS in 2000. Of these thirty-three were grown under greenhouse conditions. Six accessions that were grown under field conditions will have to be regrown. All of the increases were given combined ratings which included seed number and quality. Of the greenhouse increases, nineteen were good, ten were fair, and four were poor. Of twenty-one field increases, four were good, six were fair, and eleven were poor. Of the thirty-seven accessions started in 2000, three had zero germination. The *Beta* increase program has a carryover of fifty-five accessions, largely due lack of complete flower induction. Flowering de-induction seems to occur when growth conditions, especially night temperatures, are too warm. This problem has been solved in some of the greenhouses where we can control the temperatures well. De-induction is a problem in the field increases of wild *Beta* accessions. We will continue to work on the de-induction problem.

Seventy-three accessions of *Beta* were germination tested in 2000. Forty-two of the tested lines were new (1999) seed. Only one of these had less than 50% viability, and fourteen accessions had greater than 50% dormancy. There is a large backlog of *Beta* accessions that need germination testing so that better decisions can be made for seed increase priorities. Starting in 2001, WRPIS will double the output of germination tests. This should help greatly with the backlog of *Beta* germ tests.

A total of 420 beet accessions were distributed in 2000 in twenty-nine seed orders. Eight of the seed orders were for germplasm evaluation trials, with a total of 240 accessions in this group. Evaluation data for 1999 and 2000 has not yet been received by us. When we do get it, the data will be entered into GRIN. We also would like to request that any photos or electronic images of *Beta* accessions that researchers have be submitted for inclusion into GRIN if appropriate. We acquired 100 new accessions. One accession was backed up at NSSL.

In 2000, Dr. L. Frese visited WRPIS from Germany. We had discussions regarding the development of a *Beta* core collection, a future germplasm collection proposal to Greece, and toured the Pullman facilities. We also discussed problems related to seed regeneration with some of the more difficult accessions. We have developed an excellent working relationship with the IDBB in Europe.

In 2001 we plan to continue the seed increase program in both greenhouse and field plots. We have two experiments in progress to access protecting our over-wintering field plots. I am organizing characterization and evaluation data taken at Pullman from the last three years for entry into GRIN. Also, I am developing a Standard Operating Procedure for *Beta* germplasm maintenance at WRPIS.

SUGARBEET RESEARCH

2000 Report

SECTION D

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This research was supported in part by funds provided through the Beet Sugar Development Foundation. (Projects 620, 621, 622, and 650.)

CONTENTS

PUBLICATIONS
Abstract of Papers Presented or Published

CAMPBELL, L.G., ANDERSON, A.W., and DREGSETH, R.J. 2000. Registration of F1015 and F1016 sugarbeet germplasms with resistance to the sugarbeet root maggot. Crop Science 40(3):867-868.

Sugarbeet root maggot is a serious pest of sugarbeets on much of the US acreage. The insect currently is controlled with insecticides applied at planting time. If the few insecticides being used were removed from the market or became ineffective due to the development of resistant maggot strains, yield losses would increase substantially in some growing areas. Effective genetic resistance to this pest would reduce the dependence on insecticides and its associated costs. Two germplasms, designated F1015 and F1016, were developed and are now available for distribution to commercial breeders. F1015 and F1016 currently are the only publicly available sugarbeet root maggot resistant germplasms in a sugarbeet type background. In addition to supplying a source of resistance to the maggot, these germplasms demonstrate a minium level of resistance that is attainable if seed companies are willing to devote the necessary time and effort to a resistance breeding program.

CAMPBELL, L.G., EIDE, J.D., SMITH, L.J., and SMITH, G.A. 2000. Control of sugarbeet root maggot with the fungus *Metarhizium anisopliae*. J. of Sugar Beet Research, 37(1):57-69.

Only a few insecticides are available for controlling the sugarbeet root maggot (*Tetanops myopaeformis* von Röder). These could become less effective because of the development of resistant root maggot strains or become unavailable because of environmental concerns. Laboratory results suggested the entomopathogenic fungus *Metarhizium anisopliae* (Metschnikoff) Sorokin, had potential as a root maggot control agent and prompted field testing. *Metarhizium* inoculum was spread evenly over field plots in the fall preceding the sugarbeet (Beta vulgaris L.) crop, in the spring prior to planting, or both in the fall and spring . In 1995 trials at Hillsboro, North Dakota, the no-insecticide treatment yielded 32.6 Mg ha^{-1}, compared with 48.7 Mg ha^{-1} when a chemical insecticide was used. Root yields from the *Metarhizium* treatments ranged from 33.2 to 42.2 Mg ha^{-1}. Four-year (1996-99) average recoverable sugar yields at Crookston, Minnesota were 7161 kg ha^{-1} when no insecticide was applied, 8120 kg ha^{-1} when a chemical insecticide was used, and 8622 kg ha^{-1} when *Metarhizium* was applied in the spring and fall. Results, to date, have been encouraging; however, information on application rates and timing, formulation, and the effectiveness of *Metarhizium* in more environments is required before commercialization is feasible.

KLOTZ, K.L. and FINGER, F.L. 2001. Sucrose metabolism in postharvest sugarbeet roots: activities and properties of the major sucrolytic enzymes. 2000 Sugarbeet Research & Extension Reports. Cooperative Extension Service, North Dakota State Univ. 31:147-149.

The activities of the major sucrolytic enzymes in postharvest sugarbeet roots were determined after prolonged storage or storage under unfavorable conditions. Soluble acid invertase, alkaline invertase and sucrose synthase activities were measured in field grown sugarbeet roots after storage at 6, 12 or 21° C. Sucrose synthase was the major sucrolytic activity under all storage temperatures and durations tested. Alkaline invertase was present at significantly lower levels, while soluble acid invertase activity was barely detectable. Only alkaline invertase exhibited a change in activity that was consistent over all storage temperatures studied. The effect of temperature and pH on the activities of two sucrose synthase isoforms and the major soluble acid invertase of sugarbeet roots was also determined. All three enzymes retained a portion of their activity at the cold temperatures typical of storage. At 5° C, sucrose synthase I, sucrose synthase II and acid invertase retained respectively, 8, 14, and 16% of their activity relative to their activity at 35° C. Sucrose synthase II and acid invertase were completely inactive at temperatures of 60° C or greater. Sucrose synthase I was inactive at temperature of 65° C or greater. The optimum temperature for sucrose synthase I and sucrose synthase II activities were 50 and 45-50° C. The optimum temperature for acid invertase activity was 35° C. Sucrose synthase I and sucrose synthase II were active in the pH range of 5.0 to 8.0 and 5.5 to 7.5, respectively. Acid invertase exhibited a plateau of activity at pH 5.0 to 5.5 and its activity increased 7.5 fold with a decrease in pH from 5.0 to 3.0.

KLOTZ, K.L., and FINGER, F.L. 2000. Sucrolytic isoenzyme activities change with sugarbeet (*Beta vulgaris* L.) root development. American Society of Plant Physiologists. p.126. Abstract #594.

Three enzyme activities are responsible for nearly all sucrose catabolism in sugarbeet roots. Acid invertase, alkaline invertase and sucrose synthase activities convert sucrose to hexose sugars providing substrates for cellular metabolism and biosynthesis of cellular structures. A single soluble acid invertase isoenzyme and two alkaline invertase isoenzymes were evident in sugarbeet roots. A cell wall acid invertase activity was also present but was not characterized due to the inability to extract this activity from the cell wall. Two sucrose synthase isoenzymes were also present. In greenhouse grown sugarbeets, the soluble acid invertase isoenzyme was the predominant sucrolytic activity in seedling roots. Acid invertase activity declined precipitously after two weeks of growth and was barely detectable by six weeks of age. Two alkaline invertase isoenzymes were present at all stages of development at low levels. Although total alkaline invertase activity was relatively constant during root growth, the individual contribution of the two isoenzymes changed with development. The predominant sucrolytic activity in sugarbeet roots at all but the earliest stages of development was sucrose synthase. By four weeks, sucrose

synthase was the major sucrose catabolizing enzyme in sugarbeet roots and remained the major sucrolytic activity at all subsequent stages of development. One sucrose synthase isoenzyme was present during the first twelve weeks of growth. Two isoenzymes were present at sixteen weeks. These studies suggest that sucrose synthase is largely responsible for sucrose catabolism and the provision of metabolic intermediates during all but the earliest stages of root growth.

FINGER, F.L. and KLOTZ, K.L. 2000. Properties of a soluble acid invertase from *Beta vulgaris* L. roots. American Society of Plant Physiologists. p.127. Abstract #59.

A soluble acid invertase from six-week old sugarbeet roots was partially purified and some of its biochemical and physical properties were characterized. This invertase isoenzyme has a Km for sucrose of 8.9 mM and was not inhibited by fructose. The enzyme exhibits a plateau of activity at pH 5.0 to 5.5 and was activated 7.5-fold at pH 3.0, possibly due to the loss of inactivation by an inhibitor. The enzyme was unstable at pH values equal to or greater than 7.5 at high ionic strength. While short incubations at pH 3.0 and 4.7 caused minor losses in activity, prolonged exposures to these pH conditions partially activated the enzyme. The enzyme exhibited a sharp temperature optimum at 35° C. At temperatures above or below this optimum, enzyme activity declined rapidly, although 16% of its activity still remained at 5° C. Rapid and irreversible inactivation occurred at 40° C and above. Partial inactivation was observed at temperatures of 40° C to 50° C, while a complete inactivation of the enzyme was achieved at 55° C and above. Scholarship for FLF was provided by CAPES/MEC (Brazil).

WEILAND, J.J. 2001. Survey for the prevalence and distribution of *Cercospora beticola* tolerant to triphenyltin hydroxide and mancozeb and resistant to thiophanate methyl in 2000. 2000 Sugarbeet Research and Education Reports, Cooperative Extension Service, North Dakota State University. 31:266-271.

Triphenyltin hydroxide (TPTH) has been used extensively in the Northern Great Plains in recent years for the control of *Cercospora* leaf spot on sugarbeet. Although mancozeb and, to a lesser extent, the benzimidazole fungicides often are implemented in conjunction with TPTH for optimum leaf spot control, TPTH continues to be the most widely used compound for control of the disease. Has been used on sugarbeet in Minnesota and North Dakota only in the past few years; preliminary testing for tolerance to this fungicide is presented in this year's study. Testing in our USDA-ARS Fargo laboratory of *Cercospora* that was isolated from leaf spot in the sugarbeet fields in North Dakota and Minnesota for the tolerance or resistance to fungicides first revealed tolerance to TPTH in 1994. The testing program has continued to the present and now includes surveying for tolerance to mancozeb. Testing for baseline tolerance to tetraconazole is also beginning this year, as this represents new chemistry available to the grower for the control of leaf spot disease. The results of the study found similar presence of fungicide resistant *C. beticola* isolates to previous years.

WEILAND, J.J. 2000. Genetic transformation *Pythium aphanidermatum*. Fungal Genetics Conference. Abstract p 113.

Resistance to numerous diseases pests in sugarbeet appear to be conferred by monogenes. These include resistance to powdery mildew, Erwinia vascular necrosis, beet mosaic virus, and Fusarium stalk rot. The inheritance of resistance to the cyst nematode, *Heterodera schachtii*, is monogenic and the inheritance of resistance to the root knot nematode is being evaluated. These pathosystems are being used as models for the generation of molecular genetic markers tagging genes for disease resistance in sugarbeet. Markers generated from the study will be used to evaluate the linkage and location in the sugarbeet genome of genes conferring resistance to several pathogens. In addition, the markers will be useful in the introgression of disease resistance genes into sugarbeet parent lines using marker-assisted selection and in future cloning and analysis of these genes. The use of resistance gene analog (RGA) sequences is being incorporated into the resistance gene detection strategies. Such sequences may permit the identification of quantitative trait loci that contribute to genetically-complex resistance in sugarbeet to Rhizoctonia root rot, Cercospora leaf spot, and Aphanomyces black root diseases. The status of a project aimed at tagging a monogene conferring resistance to powdery mildew in sugarbeet caused by *Erysiphe polygoni* DC will be presented.

WEILAND, J. J. AND HALLION, J.M. 2001. Benzimidazole resistance in *Cercospora beticola* sampled from sugarbeet fields in Michigan, USA. Canadian Journal Plant Pathology. 23:78-82.

Leaves of sugarbeet (*Beta vulgaris* L.) were collected in 44 fields in Michigan following reports of inadequate control of *Cercospora* leaf spot disease with benzimidazole fungicides. Standard fungus isolation techniques were combined with fungicide resistance testing to determine if isolates of *Cercospora beticola* Sacc. resistant to thiophanate methyl (TM), a representative benzimidazole fungicide, could be obtained from the leaves. Resistance was assayed by measuring radial growth of fungal mycelia on potato dextrose agar (PDA) amended with 5 ppm TM. Conidia of *C. beticola* were recovered from 556 individual leaf spots; 102 of these isolates, from 21 of the 44 fields, were resistant to TM. Resistant isolates were recovered from most of the counties in Michigan where sugarbeet is grown. The results indicate a need to monitor *C. beticola* in Michigan for increases in the proportion os isolates exhibiting resistance to TM and for the existence of resistance or tolerance to other fungicides.

POLYMERASE CHAIN REACTION (PCR)-BASED DETECTION OF *APHANOMYCES COCHLIOIDES* USING ACTIN GENE SEQUENCES.

Project 620

John J. Weiland

A number of soil fungi have the capability to cause disease in sugarbeet and these include *Rhizoctonia solani*, *Aphanomyces cochlioides*, *Pythium aphanidermatum*, *P. ultimum*, and *Fusarium oxysporium*. When seedling damping off or adult plant root rot occur, diagnosis of the causal agent of the disease can be a time-consuming process (days to weeks). Culture of the organisms from an infected area of the sugarbeet root can lead to the recovery of a plethora of fungi, many of which have colonized the infected tissue as saprophytes.

The polymerase chain reaction (PCR) is a DNA based technique for amplifying specific sequences from the genomes of organisms. PCR technology has impacted many fields of biology, including the area of disease diagnosis in both plants and animals. Diagnostics using the PCR are sensitive and highly discriminatory, since they target genome regions whose DNA sequences have diverged throughout evolution. PCR-based diagnostics also require little time for a result to be secured (within one to two days), making them attractive to high-throughput diagnostic laboratories.

The interests in our laboratory include the development of novel diagnostic tools for disease-causing fungi in sugarbeet, as well as the development of tools for investigating the biochemistry of sugarbeet pathogenesis by fungi. For this reason, we designed our PCR assay for the discrimination of sugarbeet fungal pathogens upon DNA sequences of the actin and ribosomal RNA (rRNA) genes. The rRNA genes of all organisms harbor sequences that permit that organism to be "fingerprinted" according to that gene sequence. This fingerprinting analysis was applied to *Aphanomyces* populations that were collected in the U.S. ranging from the northern Red River Valley to (now abandoned) sugarbeet growing regions of Texas. The analysis revealed that *Aphanomyces cochlioides* populations in the central states of the U.S. are genetically uniform. Using a parallel technique of random amplified polymorphic DNA (RAPD) analysis, limited genetic diversity was detected in a field near Buffalo Lake, MN which will be the focus of investigation in 2001 (Fig. 1).

In 2001, full nucleotide sequence data will be generated from the ITS (highly variable) regions of the rRNA genes of 16 isolates of *A. cochlioides* from around the U.S.. In collaboration with Dr. Carol Windels (University of Minnesota at Crookston) virulence differences of the various isolates will be determined. Association of DNA fingerprinting type with virulence will be made according to this data. In addition, sequence analysis of this regions will permit the design of DNA primers enabling the specific detection of *A. cochlioides* using polymerase chain reaction techniques.

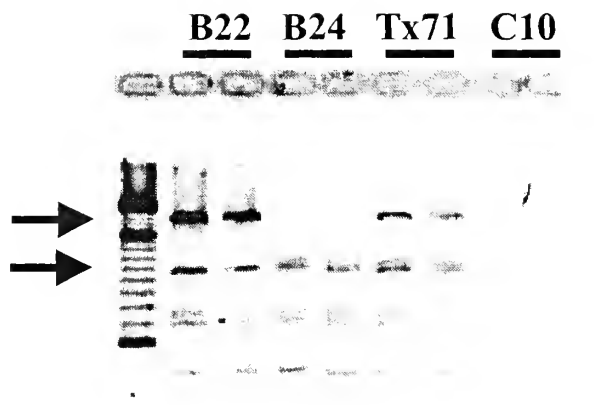

Figure 1. RAPD analysis of select single-zoospore isolates of *Aphanomyces cochlioides* obtained from diseased sugarbeet seedlings. The arrows denote amplified DNA products that distinguish isolates B22 and Tx71 from B24 and C10. Products were separated by electrophoresis in a 1.5% agarose gel (tris-borate EDTA buffer) and stained with ethidium bromide.

MECHANISMS OF RESISTANCE IN SUGARBEET TO FUNGAL AND BACTERIAL PATHOGENS

Project 621

John J. Weiland

Enzymes and enzyme inhibitors that accumulate in sugarbeet that is under pathogen stress often are associated with resisting pathogen invasion. Some of these activities are produced to strengthen natural barriers in the plant to pathogen invasion. Others are produces as an arsenal of compounds toxic to the pathogen or as inhibitors of phytotoxins produced by the pathogen. Identification of sugarbeet enzymes, and their corresponding genes, produced in defense against pathogens can further our understanding of the basis for disease resistance. Such knowledge can be used in the selection of germplasm with enhanced pathogen resistance. In addition, the cloning of the genes for defense-related enzymes and inhibitors can lead toward the production of genetically modified (engineered) germplasm for use in sugarbeet breeding programs.

In 2000, the induction of esterase, phosphatase, and other hydrolytic enzyme activities produced both by the sugarbeet plant and the invading pathogens *Cercospora beticola* and *Aphanomyces cochlioides* was examined. In the case of Cercospora-infected tissues, leaf spot lesions induced from greenhouse infections with *C. beticola* isolate 98-23 were the source of extracts prepared for the study. Many electrophoretic isoforms of esterase and phosphatase were observed on native polyacrylamide gels of extracts prepared from healthy and diseased tissue (Fig. 1). For acid phosphatase activity, a clear electrophoretic shift of the enzymes toward slower migration in the gel is seen in diseased tissues, suggesting that either novel phosphatase enzymes are being produced *de novo* or that the existing pool of phosphatase enzymes are being post-translationally modified. Although the production of novel phosphatases in the *Cercospora* fungus in these tissues cannot be ruled out, the lack of corresponding phosphatase activity in cultured *C. beticola* suggests that the activities observed are of plant origin. In the present study, no unique phosphatase activity associated with resistant germplasm was observed. Esterase activity was also examined in healthy sugarbeet seedlings and those infected with *A. cochlioides*. Native polyacrylamide gels were used to separate extracts from these tissues and comparisons were made to supernatants and extracts of mycelia of cultured *A. cochlioides*. The data show that a specific esterase activity present in low amounts in healthy seedlings is induced in infected sugarbeet seedlings (Fig. 2). In the present study, no comparison was made regarding the timing of the induction of this activity in resistant versus susceptible sugarbeet varieties, which will be the topic of research in 2001. Additionally, protease activity secreted in to the culture media by *A. cochlioides* will be investigated as a virulence component in the production of disease in sugarbeet.

In 2001, we will look at secreted esterase activity as a virulence factor in infections of sugarbeet by *C. beticola*. Secretion of the esterase examined appears to be regulated by light in the same manner as that for the well-characterized phytotoxin, cercosporin. Partial purification the activity is underway and antisera production to the purified esterase activity is anticipated by the end of 2001. In addition, leaf infiltration studies will be done with the esterase in order to determine whether the activity may contribute to virulence of *C. beticola* on sugarbeet. Future studies with *A. cochlioides*

will focus on the role of observed protease secreted by the pathogen in pathogen virulence and the nature of the induced esterase in sugarbeet seedlings. Finally, further characterization of the polygalacturonase inhibitor protein (PGIP) genes cloned from various plant species (including *Beta webbiana*) will be done; a cDNA clone will be isolated from *B. webbiana* representing the genomic cloned already analyzed to date.

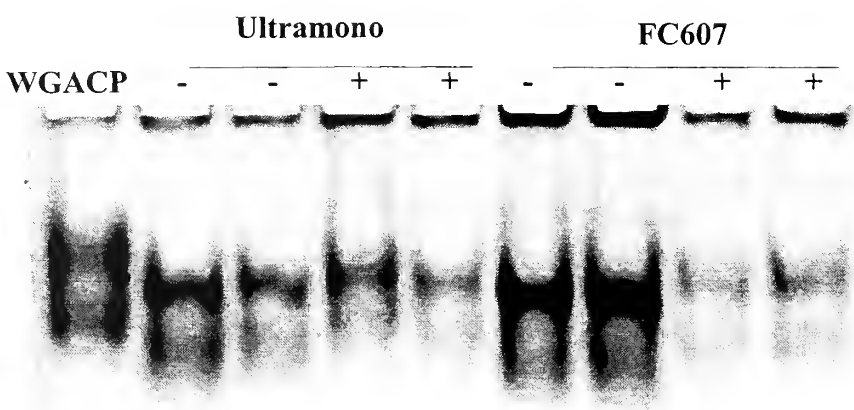

Figure 1. Acid phosphatase (ACP) activity in extracts of sugarbeet both healthy (-) and infected (+) with *C. beticola*. Extracts of leaves were fractionated by native polyacrylamide gel electrophoresis and ACP activities were detected using 4-methylumbelliferyl phosphate. Wheat germ acid phosphatase (WGACP) was included on the gel as a control. The susceptible variety Maribo 'Ultramono' was compared to the resistant germplasm FC607. Note the slightly slower migration of ACP in lanes of extracts prepared from infected sugarbeet plants.

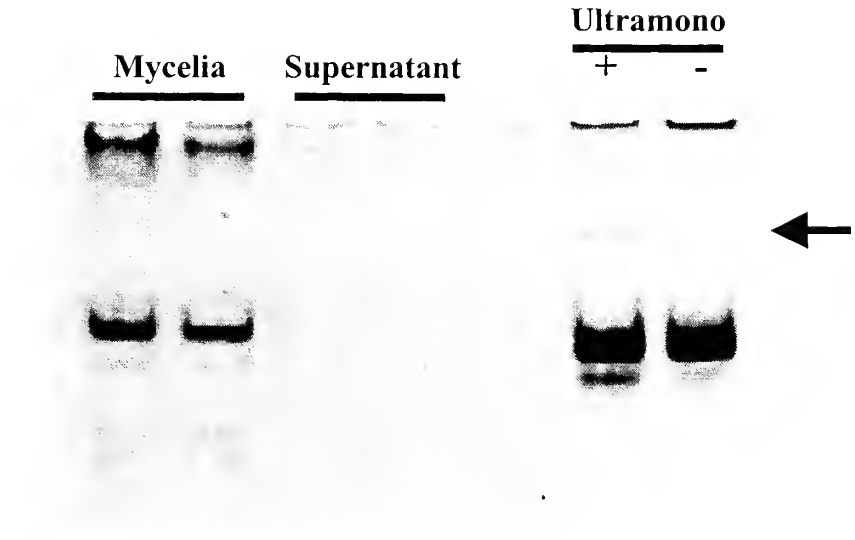

Figure 2. Induced esterase activity in sugarbeet seedlings infected with *A. cochlioides*. Extracts prepared from cultured *A. cochlioides* mycelia were compared to those prepared from sugarbeet seedlings of variety Maribo 'Ultramono'. Esterases were separated by native polyacrylamide gel electrophoresis and activities were detected using 4-methylumbelliferyl butyrate. The arrow indicates an activity that is induced in response to infection with *A. cochlioides*.

TAGGING OF GENES FOR DISEASE RESISTANCE IN SUGARBEET USING MOLECULAR GENETIC MARKERS

Project 622

John J. Weiland

Markers that tag regions of chromosomes that harbor genes contributing to disease resistance in sugarbeet can be of use in many aspects of research. Such landmarks on the genomic map can be used in marker-assisted selection in sugarbeet breeding programs. In addition the markers can provide information regarding the clustering or lack thereof regarding the distribution of resistance genes throughout the genome. Finally, chromosome markers can be integral tools in the identification of DNA clones that potentially harbor resistance gene sequences. Cloned resistance genes can be analysed for clues as to their mode of action and can be transferred between plant species using gene transfer technologies.

We have focused early efforts on the tagging of resistance to powdery mildew disease and to root knot nematode. Similar work has already been done in European laboratories the analysis of resistance to Cercospora leaf spot and Rhizomania diseases. Powdery mildew (*Erysiphe polygoni*) and root knot nematode (*Meloidogyne* spp) resistance in sugarbeet has recently been characterized by ARS colleagues in Salinas, CA. Both genes show promise for the genetic control of several races of the organisms causing these diseases. In collaboration with Drs. Robert Lewellen and Ming Yu, these resistance genes are being tagged using the random amplified polymorphism (RAPD) technique.

In 2000, additional roots typed in the field for their reaction to powdery mildew disease were received from the ARS-Salinas lab and DNA was prepared from them. Information from the typing of these roots for the presence of DNA polymorphisms associated with the resistance phenotype is being finalized at this time. In addition, a marker associated with root knot nematode resistance was cloned and sequenced. To date, the marker is 100% associated with roots that type positive for resistance to root knot nematode (Fig. 1).

In 2001, the best markers associated with resistance to powdery mildew will be cloned and sequenced. Specific DNA primers will be made in order to reduced the number of DNA bands present in the fingerprinting procedure. Additional roots from a population segregating for resistance to root knot nematode will be processed for confirmation of cloned tag for this resistance gene. Use of the marker as a predictor for presence in seedlings of root knot nematode resistance will be evaluated.

Also in 2001, a post-doctoral scientist will commence work on tagging resistance to Rhizomania (Rz gene). This will provide publically-available markers for this economically-important gene to sugarbeet breeders. The project also seeks to tag the genetic components of resistance to *Rhizctonia solani* AG2-2 and to develop methods for evaluating a sugarbeet population segregating for resistance to Aphanomyces chronic root rot. After characterization of the inheritance of resistance using this procedure, molecular marker tagging then will be applied to this population as well. As an added benefit, the inoculation and rating procedures produced from this work should be useful for screening germplasm for Aphanomyces resistance.

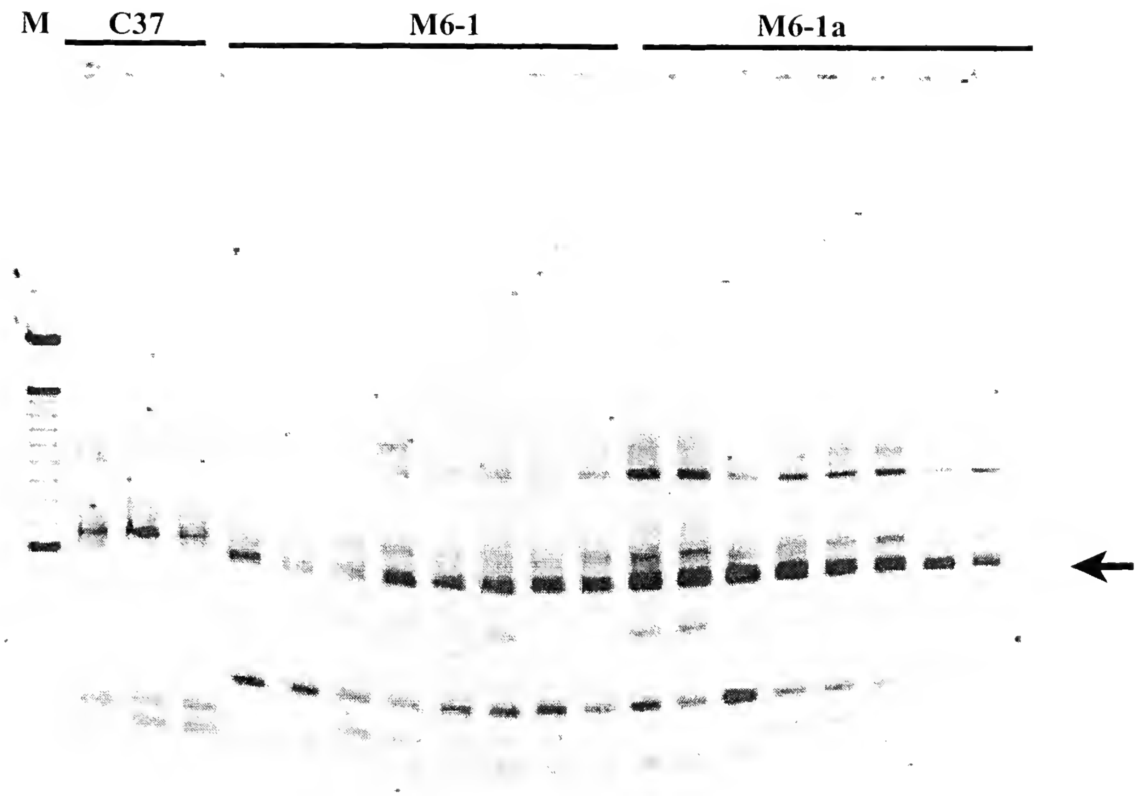

Figure 1 Molecular genetic tagging of resistance to root knot nematode. Sugarbeet DNA samples prepared from individual seedlings of germplasm accession C37 , M6-1, and M6-1a were used as template in RAPD reactions. Products of DNA amplification were separated on a 1.6% agarose gel and were stained with ethidium bromide. The arrow indicates a DNA polymorphism associated with the gene conferring resistance to root knot nematode. Note absence of this DNA band in lanes of C37, where each lane for that accession represents products derived from 7 seedlings.

SUCROSE CATABOLISM IN POSTHARVEST SUGARBEET ROOTS

Project 650

Karen Klotz

Postharvest sucrose catabolism is costly for the sugarbeet industry. Sucrose is lost during postharvest storage and processing due to the continuing metabolic activity of sugarbeet roots and the presence of endogenous enzymes capable of degrading sucrose. Until frozen, sugarbeet roots actively degrade sucrose. This metabolism is necessary to heal wounds that occur during harvest and for maintenance of healthy root tissue. The enzymes of sugarbeet sucrose catabolism are also involved in the sucrose loss that occurs when stored roots thaw and during the initial stages of processing. In both cases, cell rupture caused by a freeze-thaw cycle or slicing during the first steps of processing eliminates the cellular compartmentalization that separates sucrose from the enzymes that degrade it.

Sucrose catabolism occurs primarily by the action of three enzyme activities. Acid invertase, alkaline invertase and sucrose synthase catalyze the conversion of sucrose to the invert sugars, glucose and fructose, and uridine 5'-diphosphate glucose, a metabolically active form of glucose. Previous work determined the activity of these enzymes during sugarbeet root development. Research during the past year has focused on the role of these enzymes in postharvest sucrose loss. The activities of the major sucrose degrading enzymes were determined in postharvest sugarbeet roots after prolonged storage or storage under unfavorable conditions. The capacity of sucrose synthase and acid invertase to degrade sucrose under typical storage and processing conditions was also determined since these two enzyme activities have been implicated in postharvest sucrose loss.

The activities of the major sucrose degrading enzymes were determined in postharvest sugarbeet roots after prolonged storage or storage under unfavorable conditions. The purpose of these experiments was to determine the relative contribution of each enzyme activity to the total sucrose degrading activity of the root and to determine the effect of storage conditions on these activities. Sucrose synthase, alkaline invertase and acid invertase activities were measured in sugarbeet roots stored at 6, 12 and 21°C for zero to seventeen weeks (Fig. 1). Sucrose synthase activity was the predominant sucrose degrading activity under all storage conditions and durations tested. Alkaline invertase activity was present at significantly lower levels than sucrose synthase activity. Acid invertase activity was barely detectable. Surprisingly few changes in enzyme activity were found even after prolonged storage (Fig. 1A) or storage at elevated temperatures (Fig. 1C). Only alkaline invertase activity exhibited a change in activity that was consistent over all temperature conditions studied. Alkaline invertase activity initially declined during storage. With subsequent storage, alkaline invertase activity increased gradually to a level similar to its activity at harvest. Although a slight increase in acid invertase activity was observed in sugarbeet roots stored at 6°C, this increase was not observed in roots stored at 12 or 21°C.

The effect of environmental conditions on sucrose degrading activity was also examined for sucrose synthase and the major isoform of acid invertase. The purpose of these experiments was to determine the capacity of these enzymes to degrade sucrose under the conditions typically encountered during storage and processing. Two sucrose synthase isoforms (sucrose synthase I and sucrose synthase II) contributed to sucrose synthase activity in postharvest sugarbeet roots. The effect of environment conditions on the activity of these two isoforms were determined separately.

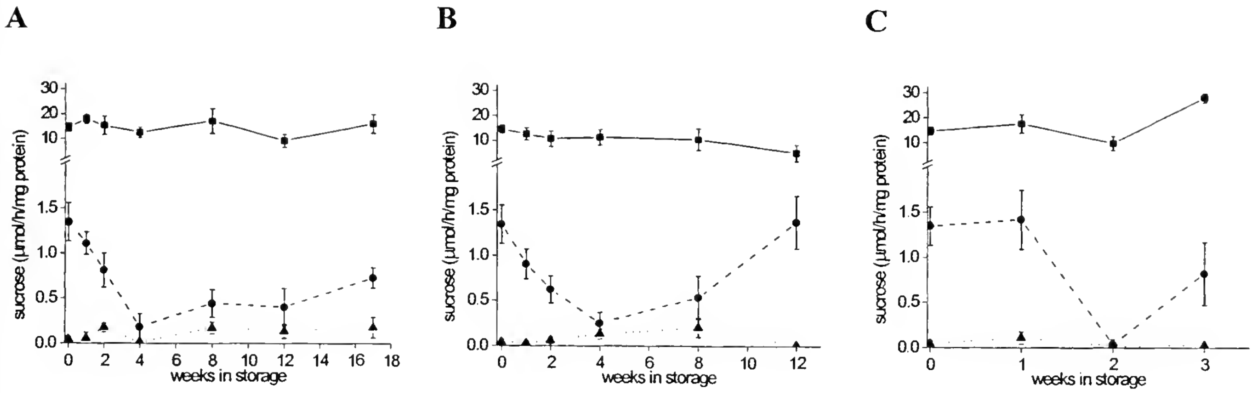

Figure 1: Sucrolytic enzyme activity in sugarbeet roots stored at (**A**) 6°C, (**B**) 12°C or (**C**) 21°C. Field-grown, hand harvested roots were stored at 95 to 99% relative humidity and sucrose synthase activity (■), alkaline invertase activity (●), and soluble acid invertase (▲) were measured after different durations of storage. Error bars = one standard deviation.

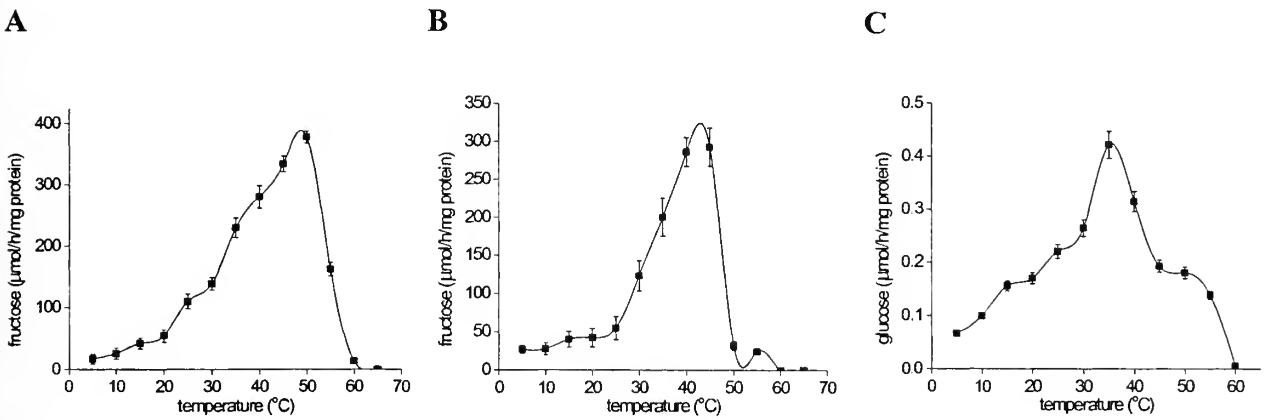

Figure 2: Temperature effect on activity of (**A**) sucrose synthase I, (**B**) sucrose synthase II, and (**C**) soluble acid invertase. Error bars = one standard deviation.

The effect of temperature on the activity of the two sucrose synthase isoforms and the major isoform of acid invertase is shown in Figure 2. The optimum temperatures for sucrose synthase I, sucrose synthase II and acid invertase activities were 50°, 40 to 45° and 35°C, respectively. Sucrose synthase II and acid invertase were completely and irreversibly inactivated at temperatures of 60°C or greater. Inactivation of sucrose synthase I required temperatures of 65°C or greater. A temperature of at least 65°C, therefore, was required to completely inactivate all three enzymes. Sugarbeet roots are typically extracted at 68 to 75°C. Although these extraction temperatures are sufficient to completely inactivate all three enzyme activities, sucrose degradation by these enzymes during processing is not precluded. Sugarbeet roots are sliced at cold or freezing temperatures and warmed to optimum extraction temperatures. A time period, therefore, exists during processing in which temperatures are not sufficient to inactivate these enzymes. Of particular note is the heat stability of the two sucrose synthase isoforms. Not only was sucrose synthase found at high levels in

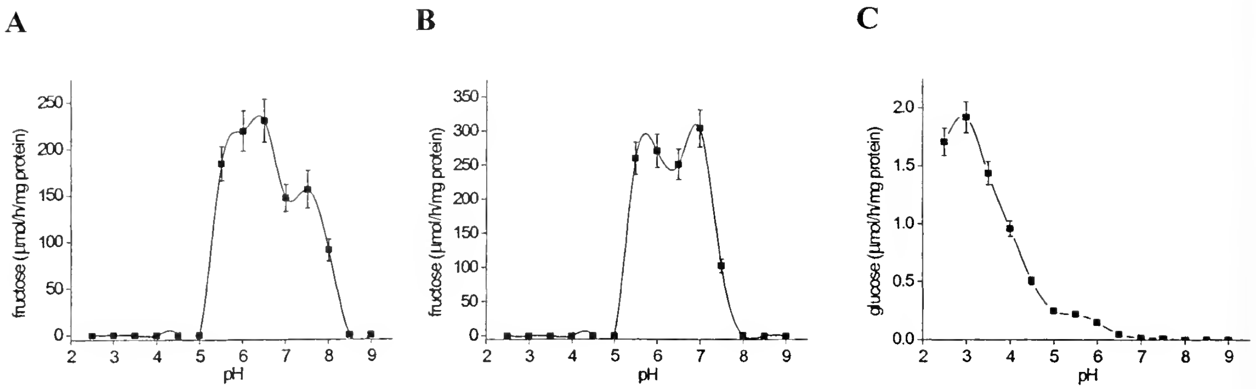

Figure 3: pH effect on activity of **(A)** sucrose synthase I, **(B)** sucrose synthase II, and **(C)** soluble acid invertase. Error bars = one standard deviation.

postharvest sugarbeet roots (Fig. 1), but the sucrose degrading ability of the two sucrose synthase isoforms increased with temperature increases up to 50° and 45°C for sucrose synthase I and sucrose synthase II, respectively. All three enzymes retained a portion of their activity at temperatures typical of storage. At 5°C, sucrose synthase I, sucrose synthase II and acid invertase retained, respectively, 8, 14 and 16% of their activity relative to their activity at 35°C. This suggests that both sucrose synthase isoforms and acid invertase are capable of degrading sucrose during postharvest storage.

The activities of the two sucrose synthase isoforms and the major isoform of acid invertase were also dependent on solution pH (Fig. 3). Sucrose synthase I was active in the pH range of 5.5 to 8.0; sucrose synthase II was active in the pH range of 5.5 to 7.5. Acid invertase exhibited a plateau of activity at pH 5.0 to 5.5 and its activity increased 7.5 fold with a decrease in pH from 5.0 to 3.0. Although the cause of the activity increase between pH 3.0 and 5.0 has not been determined, a similar pH response has been observed for an acid invertase in potato and is due to a decreased effectiveness of a specific acid invertase inhibitor. Solution pH during sugarbeet root extraction is typically in the range of 5.0 to 6.6. At these pH values, sucrose degradation can occur by the action of sucrose synthase and/or acid invertase. Lower pH values have been observed during the processing of diseased roots and pH values as low as 4.5 have been reported. Sucrose loss due to acid invertase activity would be expected to be exacerbated by these conditions.

SUGAR BEET RESEARCH

2000 REPORT

Section E

Sugarbeet and Bean Research Unit
Agricultural Research Service – USDA
East Lansing, Michigan

Dr. J. M. Halloin, Plant Physiologist
Dr. J. M. McGrath, Sugarbeet Geneticist
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This research was supported in part by funds provided through the Beet Sugar Development Foundation (Projects 710, 720, and 721)

CONTENTS

Chitinase induction: a wound response of sugarbeet tap roots.

BSDF Project 720

Subashini Nagendran and John M. Halloin. Agricultural Research Service, U. S. Department of Agriculture, Sugarbeet and Bean Research Unit, Department of Botany and Plant Pathology, Michigan State University, East Lansing, MI 48824-1312

Background:

Previous work in our laboratory showed that sugarbeet tap roots produce phenolic compounds (PCs) as part of their defense response against *Rhizoctonia solani* (RS) AG2-2. These compounds are produced at cool (<15C), but not at warm (>25C) temperatures, are formed approximately 48 hours after inoculation, and can be induced by abiotic elicitors, but not by water. Plants typically produce a group of compounds known as pathogenesis-related (PR) proteins in association with their defense responses. Chitinase is one of these PR proteins, and is presumed to act through digestion of fungus cell walls. Sugarbeet leaves produce chitinases as PR proteins in response to infection by *Cercospora beticola*. We wished to determine if chitinase activity also is increased during the defense response of tap roots, and if it's production parallels PC production in time and sensitivity to temperature.

Methods:

Holes 1cm (deep) X 3mm (diameter) were drilled into pieces of sugarbeet tap roots, and filled either with water (check), RS inoculum, or a 100ppm solution of chitosan (abiotic inducer); water and chitosan solutions were absorbed into the surrounding tissue within 20 min. Tissue pieces then were incubated at either 10 or 28°C for periods of 6 to 144 hr. Samples collected were 2mm thick cylinders of tissue surrounding the drilled holes; these were freeze dried for storage, and subsequently were ground and extracted with pH 6 phosphate buffer, and "native" proteins in the extract were separated by electrophoresis on glycochitin-containing polyacrylamide gels at pH 8.9. Chitinase activity was detected by enzymic digestion of glycochitin in the gels at pH 5.0. Residual glycochitin in gels was stained with fluorescent brightener dye at pH 8.9 and observed under UV light.

Results:

Both RS and solutions of chitosan elicited production of 2 discrete bands of chitinases within 12 hr., and this activity increased through at least 48 hr. post-treatment. Maximum production occurred within 48 hr, in tissue pieces incubated both at the cool and at the warm temperature. Additionally, production of chitinases occurred, albeit at a reduced rate, in the water-treated tissues.

Discussion:

Chitinases are produced in sugarbeet tap roots as part of their overall defense system. However, production of chitinases at both cool and at warm temperatures clearly differentiates this response from PC production and from observed defense against *R. solani*. Additionally, chitinase production occurs more quickly than PC production. Formation of chitinases within water-treated tissues indicates that this is a wound response, rather than a disease-related response. Chitinases may provide useful PR protein markers for future studies on the molecular basis of the wound response in sugarbeet roots.

Distribution of Cercospora leaf spot lesions on green and white sectors of chimeral sugarbeet leaves.

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Background:

Recent research on induced resistance in plants of *Arabodopsis thaliana* has demonstrated greater persistence of the signal for resistance induction within albino tissues than in green ones. Typically, the youngest leaves of *Cercospora*-infected sugarbeet plants contain no disease lesions, whereas older leaves contain numerous lesions; this difference may be due to less susceptibility of younger tissues, as well as to less exposure of young tissues to inoculum. Occasionally, sugarbeet plants exhibit chimeras, in which both green and albino tissues occur on individual leaves. We reasoned that, in parallel with observations on *A. thaliana*, albino sectored sugarbeet leaves, on previously-infected plants might exhibit greater resistance of albino tissues than of green tissues to *C. beticola*.

Methods:

We examined the relative abundance of *C. beticola* lesions on naturally infected, green and white chimeral tissues of sugarbeet leaves in commercial fields near Bay City, MI, to determine if they differed in their susceptibilities to the pathogen.

Results:

Chimeric plants were found at a frequency of approximately one plant per 2.5 acres, or about $1/10^5$ plants. Contrary to our expectations, the youngest infected chimeral leaves contained lesions only on albino sectors. Slightly older leaves contained lesions on both green and albino sectors, but lesions were more abundant on albino sectors. Albino sectors thus were judged more susceptible to leaf spot than green sectors.

Discussion:

Green and white chimeric sugarbeet leaves may provide a useful system for demonstration of differential gene expression in association with resistance to leaf spot disease. A major problem in predicting epidemics of Cercospora leaf spot of sugarbeets and in scheduling protective spraying is a lag of 7 to 10 days between initial infection and appearance of disease lesions. The greater observed susceptibility of albino tissues than of green tissues of chimeric plants may result in earlier appearance of disease lesions on the chimeric plants than on other sugarbeet plants. Such an event would allow more reliable scheduling of protective sprays. Observations will be made in 2001 of the dates of appearance of *Cercospora* lesions on chimeric and normal plants to determine if such alteration of predictive methods is feasible.

Seedling diseases of sugarbeets in Michigan: Isolations and metalaxyl tolerance of *Pythium* spp. and the development of a seedling disease nursery.

BSDF Project 721

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Introduction:

Michigan sugarbeet growers have expressed concern over poor stand establishment of the crop in recent years. In 1999-2000, we surveyed fields exhibiting stand problems for seedling disease. The usual seedling pathogens were found, including *Pythium* spp., *Aphanomyces cochlioides*, and *Rhizoctonia solani*., with *Pythium* spp. predominantly isolated from early planted beets (Figure 1). Since more and more MI growers are planting early, an improved understanding of Pythium seedling disease is important, especially the actual species causing this disease. Most seed in MI is treated with metalaxyl, a fungicide specific against *Pythium* and related Oomycete genera. Brantner and Windels (1998) found some metalaxyl tolerance in Minnesota *Pythium* isolates, raising the question of whether metalaxyl tolerance was also present in MI. Objectives of our study were to: 1) identify to species pathogenic *Pythium* isolated in the disease survey and 2) test them for tolerance to metalaxyl. We also describe the first stages of the development of a disease nursery for Pythium and Aphanomyces seedling disease in MI. Establishment of disease nurseries has improved breeding efforts for many sugarbeet diseases. One difficulty in establishing a disease nursery is finding a suitable location with high concentrations of inoculum in the soil; efforts to inoculate seedlings or soil in field have been ineffective or impractical on a larger scale. A site on the Bean and Beet Research Farm, Saginaw, MI, historically provides poor stands of sugarbeets, despite a favorable soil texture for seedling emergence. Previous work has shown that soil at the site contains high populations of the pathogen *Pythium ultimum*, which causes early season seedling disease of sugarbeets, and of *Aphanomyces cochlioides*, which causes later season seedling disease. We initiated studies in 2000 to demonstrate the potential of this area as a seedling disease nursery.

Methods:

Pythium isolates were obtained as part of a larger overall survey for seedling disease pathogens, from fields identified as having seedling disease or stand problems by Monitor Sugar Co. or Michigan Sugar Co. personnel. Diseased seedlings were collected and *Pythium* spp isolated by standard methods. Seedlings were washed free of soil and incubated in dH_20 for 1-2 days then plated on corn meal agar amended with rifampacin and benomyl. *Pythium* isolates were also obtained from soil samples taken from the same fields using a bioassay procedure. Field soil was diluted 50% with a sterilized sandy loam-vermiculite mix to prevent crusting and planted with 25 sugarbeet seeds (untreated or treated with metalaxyl) in 9 cm round pots. These were incubated at 15 or 25°C to mimic early and late-planting soil temperatures, and watered daily to encourage disease. *Pythium* spp. were isolated from diseased seedlings using the procedures outlined above.

To test pathogenicity and identify *Pythium* spp. obtained, a simple assay was developed: 4-

5 surface-sterilized sugarbeet seeds and a Pythium isolate were co-plated on a 9 cm petri dish containing 1.2% water agar. In 4-5 days, pathogenic isolates caused lesions on the germinating seedlings and formed characteristic structures (oospores and zoosporangia) useful for identification.

Pathogenic isolates were tested for metalaxyl tolerance using the methods outlined in Brantner and Windels (1998) except that 6.0 cm petri plates were used for the metalaxyl dilution series which used less media and gave results in 1-2 days. EC_{50} values (the concentration at which fungal growth is inhibited 50%) were used for comparison between varieties and were obtained as in Branter and Windels (1998).

A single seed lot of a sugarbeet variety (no commercial variety is known to have resistance against *Pythium* spp.) was subjected to various seed treatments (see Table II) and planted into the pathogen-rich soil ("bad ground") at the Bean and Beet Farm, Saginaw Co., MI in 2000. Plots were planted early and late in the spring (early April, early June) with eight replications for each treatment. The entire experiment was replicated on virgin soil ("good ground": not planted to beets in recent memory) nearby as a control. Both locations were planted on the same dates.

Results and discussion

P. ultimum and *P. aphanidermatum* are thought to be the two main *Pythium* pathogenic to sugarbeet. While *P. ultimum* was most commonly isolated from the soil bioassay, several *Pythium* spp. were also isolated from diseased seedlings in the field and the soil bioassays: *P. dissotocum* and *P. myriotylum,* and one isolate each of *P. aphanidermatum* and *P. irregulare* (Table I). Interestingly, *P. ultimum* was not isolated directly from the field until later in the growing season, although very common in the soil in these fields. *P. dissotocum* was isolated from the field with some frequency, but not from the soil bioassay, and was also weakly pathogenic on the pathogenicity/identification assay plates. Other *Pythium* spp. were localized to single fields. This is the first isolation of *P. dissotocum* since the 1920's in MI, and the first isolation of *P. myriotylum* in MI.

Figure 2 shows the average metalaxyl tolerance of each species isolated (only one isolate of *P. aphanidermatum* and *P. irregulare* were tested); some isolates have a moderate level of tolerance to metalaxyl. Of note is the low tolerance (basically negligible) of *P. ultimum.* In combination with the results above, it is belived that metalaxyl seed treatments largely control *P. ultimum*, especially in early plantings. *P. dissotocum*, a fairly weak pathogen, may be exploiting this available niche to some extent. Also noteworthy is the fact that (except in *P. ultimum* isolated from one field (see below)) all *Pythium* isolates with metalaxyl tolerance form zoospores: these spp. can create single or few-isolated "epidemics" more readily than *P. ultimum.*

Stand establishment in the seedling disease nursery was poor in the early season planting on the bad ground. (Table II) At the early planting date, Tachigaren-pelleted seed provided superior stand establishment to other treatments. At the later planting date, where Aphanomyces seedling disease is likely, no benefits were shown, probably due to the lack of excess soil moisture that facilitate pathogen movement and contribute to plant anoxia. There were no significant differences among any treatments on the good ground.

Table I shows that P. ultimum isolates from the "Nursery" field had some of the largest tolerances to metalaxyl observed. The seed treatment results indicated below indicate that Tachigaren may provide some cross protection against these isolates of Pythium ultimum, although a signifigant caveat is the presence of A. cochlioides in this field. This experiment will be repeated

in 2001 with a very early planting date to minimize the influence of A. cochlioides.

Figure 1: Pathogen Incidence in Disease Survey 1999

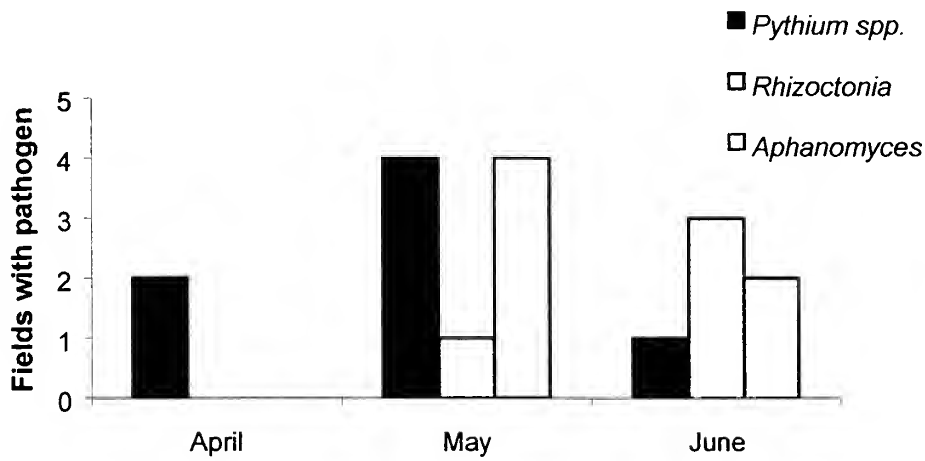

Figure 2: Metalaxyl Tolerance EC^{50} ug/ml of pathogenic *Pythium* spp.

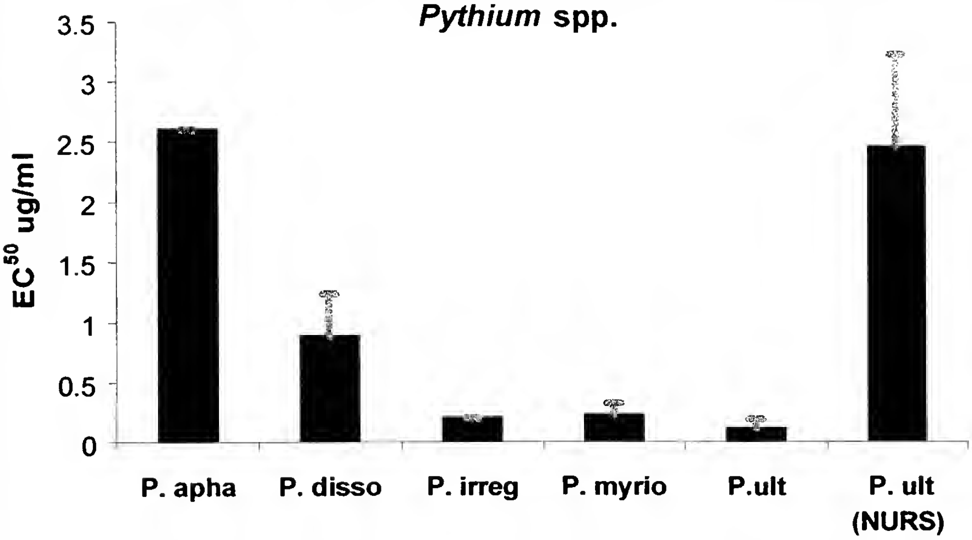

Table I: A. *Pythium* spp. isolated from field soil bioassay. Soil was sampled from 14 fields, pots were incubated at 15 or 25 C to mimic early and late planting soil temperatures. **B.** *Pythium* spp. isolated directly from diseased plants in the field.

A. (no. fields isolated from)		
	15 C	**25 C**
P. ultimum	5	10
P. irregulare	1	0
P. aphanidermatum	0	1
P. myriotylum	0	1

B. (no. fields isolated from)			
	April	**May**	**June**
P. ultimum	2	3	0
P. dissotocum	0	4	2
P. aphanimdermatum	0	1	0

Table II. Effect of seed treatment on stands (plants per 25 ft) of Early and Late planted beet seedlings on "good" or "bad" ground at B&B farm. Means with the same letter are not significantly different at the 95% confidence level. Means are compared only within each ground/planting.

TREATMENT	EARLY PLANTING	LATE PLANTING
	Bad Ground	
1 Untreated	17.88 bc	34.25 b
2 Apron + Thiram	12.88 c	37.88 a b
3 PAT	20.00 bc	43.75 a b
4 PAT + Tachigaren 45	34.81 a	43.95 a
5 PAT + Tachigaren 75	27.82 ab	43.64 a b
	Good Ground	
1 Untreated	55.00 a	62.45 a
2 Apron + Thiram	49.63 a	68.76 a
3 PAT	56.25 a	68.50 a
4 PAT + Tachigaren 45	51.38 a	73.38 a
5 PAT + Tachigaren 75	46.38 a	61.75 a

Divergent selection for intensity of the defense response against Rhizoctonia solani in sugarbeet tap roots: some anecdotal observations.

BSDF Project 720

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Background:

Typically, sugarbeets in Michigan may be infected by *Rhizoctonia solani* AG2-2 during the warmest portion of the summer, early to mid July, resulting in development of crown and root rot. Development of the rot ceases with the onset of cooler temperatures in mid August, often leaving tap roots only partially rotted. Interestingly, if warm weather returns following such a cool spell, rot does not resume at the site of the previous lesion, even though fungus inoculum is abundant in the rotted tissue still present. Instead, a sharp demarcation zone appears between the previously infected tissues and healthy ones; this phenomenon indicates the occurrence of a strong defense response within the healthy tissues adjacent to the rot. This defense response also can be observed in harvested field roots or in pieces of tap toots, under more controlled conditions in growth chambers or incubators. Healthy tap roots or root pieces are inoculated with *R. solani* and then placed either at cool (eg. 10 – 15° C) or warm (eg. 25 – 28° C) temperatures. Rot develops in tissues at the warm, but not at the cool temperature. If the roots then are moved after several days to the alternate temperature regime, no rot develops in the tissues first incubated at the cool temperature; conversely, rot ceases upon movement of rotting tissues from the warm temperature to the cooler temperature, and will not resume if, after several days, the tissue is returned to the warmer temperature.

I (Halloin, 1994) described this defense response, and discovered that it was accompanied by production of o-dihydroxy phenolic compounds (PCs) within the healthy tissue immediately adjacent to the rot. It was felt that these PCs were likely to be fungitoxic, and thus important components of the defense system, as well as useful chemical markers of it. Subsequent attempts to extract, characterize and bioassay the PCs have proven uniformly unsuccessful. The initial report of the PCs suggested that their production was more intense in roots of varieties (germplasms) with genetic resistance to crown and root rot than in susceptible varieties. However, subsequent studies have shown much variability within germplasms for intensity of the PC response, and no consistent differences between resistant and susceptible germplasms.

Consistent association of the PC response with the temperature-related defense response suggested that intensity of this PC response might be associated with overall intensity of a more generalized, temperature-related defense response: sugarbeets tend to be more resistant (or less susceptible) to many diseases at cool than at warm temperatures. This putative association, together with the observation of variability in the intensity of PC production suggested that selection within germplasms for intensity of PC production might be possible, and that such selection might have effects on intensity of broad aspects of host resistance to diseases. This report describes observations made during initial attempts to do divergent selection for intensity of PC production within eight germplasm lines having known differences in their susceptibilities to Rhizoctonia crown and root rot.

Methods:

Seeds of eight inbred lines were planted at the Michigan State University, Botany Farm in May, 1997, and were grown until October, 1997. The eight lines were: FC701/5, 88B1-18, both highly resistant to Rhizoctonia crown and root rot, 88B22, 88B24, 94H6, and 93H1, all of which showed intermediate, but sequentially decreasing, and apparently segregating resistances to the disease, and NBI and L19, both of which were highly susceptible to crown and root rot. Plants were harvested, foliage removed, and tap roots were washed free of soil and taken to the laboratory; 100 tap roots with 3 to 5 inch diameters were used for each line.

Tap roots were assigned identification numbers and were bisected longitudinally, in such a manner that the vertical groves, the root tip, and the crown growing point remained with one of the pieces, which was placed in a cold room for future use. The remaining root pieces were used for assessment of the intensity of their PC production. Holes (3mm diameter x 1 cm deep) were drilled into the thickest portion of each piece. Six millet caryopses on which *R. solani* had been grown were placed into each of the drilled holes, tissue pieces were placed individually into perforated plastic bags, and placed into an incubator at 10° C for four days.

Inoculated root pieces were returned to the laboratory, bisected longitudinally through the inoculation sites, and sprayed sequentially with solutions of 10% $NaNO_2$, 20 % urea, 10% acetic acid, and 0.1N NaOH as described previously (Halloin, 1994) for detection of o-dihydroxy PCs. Identities of the 10 root pieces from each line exhibiting the lowest intensity of red color development were noted and designated "LP" (= low phenolic response); similarly, the 10 pieces exhibiting the highest intensity of red color development were noted and designated "HP" (= high phenolic response). Root pieces in cold storage, corresponding in identities to the selected pieces, were planted into 16 soil boxes approximately 1.5" x 1.5" x 8" deep, and left in cold storage for an additional 10 weeks to allow rooting, and to induce bolting. Upon bolting of plants, individual boxes (each containing 10 roots of a single selection type, LP or HP, from a single line) were distributed to isolated locations throughout the Michigan State University greenhouse complex for flowering, pollination, and seed production. Ripened seeds were harvested, manually abraded to remove excess cork, weighed, and stored at –20° C for future use.

Seeds of the 16 selections as well as seed of the original eight lines were planted at the MSU Botany Farm in 1999 in an attempt to do a recurrent cycle of selection and to assay the roots for intensities of their PC production.

Results and Discussion:

Seed production was satisfactory among most of the selections, with more than 30 g of seeds being produced by all selections except 88B24-HP, NBI-HP, NBI-LP, L19-HP and NBI-LP, which produced 22.0g, 6.9g, 10.9g, 3.1g, and 0.6g, respectively. There seemed no tendency for more seed production among either the HP or LP selected plants, however, the two lines selected for high susceptibility to crown and root rot produced very few seeds. It is not known if high susceptibility to crown and root rot and low seed productivity are in any way associated.

Seeds were planted in 4 row plots with approximately 100 seeds per 24' row in 1999, except that fewer seeds of the 5 low seed producing selections were planted due to their limited availability. Field emergence was poor in this experiment, and no plants emerged in any of the plots planted with LP selections. The complete failure of LP selections to emerge seems worthy of further investigation;

an initial laboratory test of seed germination (data not taken) showed lower and slower germination of some of the LP selections than among the other selections.

The small number of surviving plants in the 1999 planting, and the complete failure of the LP selections to emerge led too abandonment of the 1999 experiment. Additionally circumstances limiting production of inbred seed of selected materials at this location (East Lansing, MI) caused temporary discontinuance of these experiments. When the experiments are resumed, plans include testing selections for seed vigor, and stand establishment as well as for resistance/susceptibility to seedling pathogens and crown and root rot, as possible pleiotropic relationships between PC production and any of these factors might prove extremely useful.

Reference:

Halloin, J. M. 1994. Localization of phenolic compounds in crowns and roots of healthy and Rhizoctonia solani-infected sugar beets. Plant Sci. 99:223-228.

Use of mixtures of resistant and susceptible sugarbeet varieties decreases yield losses from Rhizoctonia crown and root rot.

BSDF Project 722

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Introduction:

Rhizoctonia crown and root rot is an economically important disease of sugarbeets in Michigan with few methods available for its control besides genetic resistance. Taproots of resistant varieties, however, have a markedly lower yield and percent sugar than commonly planted susceptible varieties and are only recommended for use in severely infested fields. Since the majority of affected fields have moderate Rhizoctonia crown and root rot disease pressure, we tested the effect of variety mixtures on disease incidence, yield and % sugar in these situations. Rhizoctonia solani, the causal fungus, is patchy in distribution, spreading slowly throughout a growing season: it was thought that resistant beets could interdict the spread of the fungus, protecting susceptible beets and boosting yields. We did experiments to determine if use of variety mixtures containing both resistant and susceptible varieties would provide satisfactory disease control.

Methods:

In 1998-2000 plots were planted in fields thought likely to have Rhizoctonia disease problems. Due to the patchy nature of the disease, plots were 4-6 rows and 300-800 m long, to average out disease intensity between plots. Each plot was planted with various mixtures of susceptible and resistant varieties (Table I, II) along with control plots with 100% susceptible or resistant varieties. Each treatment was replicated 4-5 times. Counts of disease incidence were taken at each site 2-3 times after the first onset of Rhizoctonia symptoms. Plants with aboveground symptoms characteristic of the disease were included in the counts. Yield and % sugar (average of 3 samples containing 10 beets) were obtained at harvest.

Results and Conclusions:

Disease severity varied between sites. Most locations had moderate disease pressure, but two sites in 1999 had no Rhizoctonia disease and one site in 2000 had severe Rhizoctonia disease providing useful bases for comparison. Disease incidence in each field generally followed a linear trend, directly related to the proportion of the susceptible variety in the mixture (Table I). Yield and RWSA (Table II), however, were generally highest with the incorporation of 16% or 33% resistant variety in fields with moderate disease pressure. Amelioration of losses by variety mixtures appears to be mainly due to compensation by surviving (resistant?) plants within or adjacent to diseased location in the fields. These mixtures did not negatively impact yields in fields with little to no disease (in 1999) and had an intermediate yield in the location with severe Rhizoctonia disease. We recommend a 20%-25% mixture of resistant to susceptible seed under conditions where losses due to crown and root rot are anticipated.

Table I. Yields (tons/A) and (RWSA (lbs/A)) for variety mixtures. S= Susceptible, R=Resistant variety. 0 = no disease. + = moderate, ++=severe disease.

YEAR	1998		1999				2000	
Farm	98-1	98-2	99-1	99-2	99-3	99-4	00-1	00-2
Disease	+	+	+	+	0	0	+	++
Mixture	E-17 RH3			C-648 C-1353	E-17 RH-3		E-17 RH-5	
100 % S	19.6 (4734)	13.8 (3485)	19.9 (4765)	19.5 (5131)	28.7 (7975)	25.4 (6687)	21.28 (4451)	14.93 (3034)
84% S 16% R	19.9 (4698)	14.4 (3488)	21.1 (5234)	18.5 (4708)	30.0 (8174)	25.9 (6671)	--	--
75% S 25% R	--	--	--	--	--	--	21.73 (4799)	16.25 (3222)
67% S 33% R	19.2 (4579)	14.3 (3578)	19.2 (4598)	21.9 (5396)	29.3 (7666)	25.9 (6675)	--	--
50% S 50% R	18.9 (4174)	13.8 (3394)	19.5 (4776)	20.9 (5321)	29.2 (7510)	25.1 (6818)	--	--
100% R	17.3 (3771)	13.3 (3046)	16.5 (3826)	19.5 (4890)	29.3 (7696)	25.0 (6090)	21.57 (4610)	18.20 (3647)

Table II. Mean Incidence of Rhizoctonia crown and root-rot symptoms in variety mixtures. (Mean number of diseased plants per plot) Plots 4-6 rows x 300-800 m long. Means with the same letter are not significantly different. Two out of four fields surveyed in 1999 had no disease. S= Susceptible variety, R=Resistant variety. 0 = no disease. + = moderate, ++=severe disease.

YEAR	1998		1999		2000	
Farm	98-1	98-2	99-1	99-2	00-1	00-2
Dis. Sever.	+	+	+	+	+	++
Mixture	E-17 RH-3			C-648 C-1353	E-17 RH-5	
100 % S	6.62 a	15.67 a	14.00 a	16.79 a	20.67 a	402.46 a
84% S 16% R	5.29 a	14.29 a	10.42 ab	22.67 a	--	
75% S 25% R	--	--	---	---	10.87 a b	284. 58 a
67% S 33% R	4.48 a	11.95 a b	9.50 ab	16.17 a	--	--
50% S 50% R	5.81 a	11.14 a b	9.42 ab	17.13 a	--	--
100% R	3.48 a	4.57 b	2.04 b	13.85 a	1.80 b	69.25 b

AGRONOMIC EVALUATION OF SMOOTH ROOT RELEASES AND PROSPECTIVE RELEASES – 2000

Joseph W. Saunders, J. Mitchell McGrath, Tim Duckert
USDA - Agricultural Research Service

The agronomic test was planted May 3 on ground North of the Bean and Beet Farm on land that had not previously been planted to beets. Field preparation and pre-emergence weed control were as in past years. Emergence was very good, and plots were thinned to 4 - 6 inch spacing using a mechanical thinner on June 19. Field design was RCB with 6 replicates of 24 entries in 2-row plots. Harvest was on October 3, and juice was pressed on October 4. The efforts of Michigan Sugar Lab are gratefully acknowledged for providing the quality sample tests. We considered this test reliable and well executed.

Twenty-four entries were evaluated for agronomic performance (sorted on RWSA in Table 1), and smoothroot score as a surrogate measure for low soil tare. Smooth-root scores are reported consistent with previous years, where lower values reflect a shallower suture (groove) in the root, hence less potential for soil adherence.

Compared with averages for 1999, averages for entries tested in 2000 were slightly lower for all yield traits, although quality traits (e.g. purity) was slightly better. Smooth-root scores were slightly worse in 2000 than in 1999. However, the entries tested in 2000 were different than in 1999. Seven entries in 2000 had been tested in 1999.

EL04 and EL02 were selected for smooth-root and rhizomania resistance (cooperative with R. Lewellen, Salinas, CA) and performed significantly better in 2000 than in 1999. These lines have been subjected to two further rounds of rhizomania mass selection in Salinas CA since the seedlots tested here. Also, these lines have been mixed as they derive from a reciprocal cross originally made by C. Theurer (USDA-ARS retired).

Smooth-root lines SR95 and SR96 (a soon to be released germplasm aka 95HS6 / 96HS3) performed very well in 1999 but did not rank as well in 2000. 98J34-01, 98J41-01, and 98J24-01 (each early generation advancements from smooth-root and traditional East Lansing materials) were repeat tested in 2000 for evaluation prior to release.

Eight entries were included for evaluation of relative performance. Two of these were USDA-ARS Fort Collins, CO releases FC727 and FC709-2. Another was EL52, an East Lansing selection for Rhizoctonia crown and root rot resistance. Two recent increases of ACH185 and three of USH20 were tested because these five seedlots are being used extensively in our emergence and *in vitro* germination studies. These seedlots were specially reconstructed in 1999 with the help of West Coast Beed Seed, Co. of Salem, OR. It was somewhat surprising that their agronomic values were not more tightly clustered together within varieties.

Nine additional breeding lines from Dr. Joseph Saunders smooth-root, higher sucrose, combined disease resistance, and monogerm germplasm improvement efforts were also tested (e.g. 'J' lines). No experimental hybrids were included this year. Of the 12 entries indicated with a "J", four (98J15, 99J04, 98J14, and 00J03s03) are narrow selections from smooth-root materials, and the remainder are from intercrossed smooth-root and traditional East Lansing germplasms.

TABLE 1: 24 entries ranked according to Recoverable White Sugar per Acre (RWSA). Higher numbers are better, except for Amino N and SR (Smooth Root).

Entry	RWSA	RWST	Suc %	Tons / Acre	CJP %	Amino N	SR
EL04	7314	218.1	15.42	32.42	93.44	8.02	1.8
EL02	6781	213.3	15.40	31.67	92.57	11.50	1.8
98J36-00	6411	231.9	16.28	27.65	93.53	8.68	2.0
SR95	6393	228.7	15.77	27.95	94.60	8.37	1.8
98J34-01	6260	229.7	15.98	27.33	94.02	10.95	2.0
98J41-01	6214	237.5	16.50	26.17	94.02	8.83	1.8
SR96	6196	240.9	16.70	25.70	94.10	8.63	1.7
98J23-00	6116	241.4	16.62	25.58	94.46	7.48	2.0
99J04-00	5886	224.9	15.80	26.18	93.70	8.80	2.2
ACH185-1 (990382)	5813	245.4	16.47	23.72	94.78	8.05	2.4
99J12-01	5771	228.6	15.97	25.18	93.90	8.68	2.2
EL52	5754	223.4	15.75	25.78	93.48	9.77	2.4
USH20-2 (990377)	5703	226.3	15.65	25.17	94.42	7.27	2.3
99J28-00	5449	228.5	16.13	23.88	93.42	8.40	2.2
FC727	5206	247.9	17.13	21.00	94.18	6.33	2.5
98J24-01	5190	247.6	17.14	19.52	94.14	7.04	1.7
98J15-00	4946	209.9	14.73	23.42	94.05	9.17	1.5
USH20-1 (990375)	4803	226.1	15.63	21.20	94.48	8.05	2.5
98J14-00	4679	196.1	13.92	23.72	93.73	10.85	1.7
98J38-00	4645	232.2	16.02	19.98	94.55	9.60	2.0
ACH185-2 (990384)	4559	232.3	16.07	19.60	94.38	6.70	2.3
FC709-2	4438	233.8	16.52	19.07	93.28	9.47	2.5
USH20-3 (990379)	4409	226.4	15.50	19.75	95.00	8.16	2.3
00J03s03	3250	230.2	16.08	14.23	93.98	7.80	2.2
Mean	5519.1	228.95	15.96	24.00	94.00	8.64	2.08
CV	15.3	3.95	3.74	14.55	0.69	28.79	10.68
LSD (0.05)	1057.9	11.33	0.75	3.99	0.81	2.85	0.25

Large plot disease evaluation and selection of two recent germplasm releases, EL52 and SR96

J. Mitchell McGrath and Tim Duckert
USDA-Agricultural Research Service

Two recent germplasm releases were planted in large selection plots at the Saginaw Valley Bean and Beet Research Farm. EL52 was released as predominantly selected for Rhizoctonia resistance, while SR96 was released primarily selected for smooth-root and higher sucrose content. Neither release was selected for *Cercospora* nor *Aphanomyces / Pythium* resistance, although their pedigrees include lines that do have tolerance to these diseases. The goal was to reselect individuals from relatively large populations that showed enhanced tolerance to *Cercospora* and *Aphanomyces / Pythium*. No seed treatments were used in these tests in order to select against seedling disease susceptibility.

For *Cercospora*, twelve 360 foot rows were planted May 3 to each release, alternating EL52 and SR96 every 4 rows (target 8,000 plants per release). Emergence and stand establishment

was very good, and stands were mechanically thinned on June 19. Plots were inoculated with *Cercospora* mid-July, but infection was low until mid-August. From mid-August, the disease progressed quickly. Plants that showed few signs of leaf spot infection relative to their neighbor plants were marked August 24, and marked plants were re-evaluated and harvested September 15. Approximately 30 plants of each release were harvested for seed increase in 2001. The severity of disease was less in EL52 than SR96. However, both releases had individuals with limited disease symptoms.

For *Aphanomyces / Pythium* selection and evaluation, eight 90 foot plots of each release were planted May 4 in plots having a history of poor beet growth due to high seedling disease pressure. All major groups of seedling disease fungi were isolated here in 1999 and 2000, with *Pythium* being particularly prevalent (John Halloin, pers. comm.). Emergence was poor for both EL52 and SR96, and growth of emerged plants was weak and slow. Survivors were harvested (10 roots of each release) as potential resistant selections on September 15, for seed increase in 2001.

Germination and emergence of breeding materials from long-term storage

J. Mitchell McGrath and Tim Duckert
USDA-Agricultural Research Service

The objective of this test was to examine germination and emergence from long-term sugar beet breeding lines stored on the Michigan State University campus Crops Field lab. A new state-of-the-art sugar beet seed storage area was completed in 2000, and evaluation of stored seedlots for viability was needed prior to depositing them into the new facility. Additionally, this was an opportunity to re-evaluate older USDA germplasm that may not have been released to the industry. Seedlots had dates from 1966 to 1990, with the majority from the 1980's. These periods coincide with the breeding programs of Dr. George Hogaboam and Dr. Clair Theurer.

3504 entries were planted May 3 & 4 in single row plots (ca. 2.0 grams per entry), of which only 461 (13.2%) emerged. Of these 461 seedlots, ca. 25% showed emergence comparable to the check variety E17, ca. 50% had significantly less emergence than the check, and in the remaining 25% only one to five plants were present.

Plants were allowed to grow until July 31, when selections were made from 250 representative plots. Selections were generally made from plots that had higher emergence, with selection against any roots with obvious root disease. Over 300 roots were collected and placed in cold storage for vernalization. These selections will be intercrossed, in at least two separate groups, in summer of 2001 for agronomic evaluation and further breeding and selection in subsequent years. The two separate groups are represented by (1) a large set of 'traditional East Lansing' materials from the Hogaboam program, and (2) a set of sugar x fodder beet hybrids and derivatives from the Theurer program originally used to evaluate their potential as ethanol 'fuel' beets.

Leaf spot evaluation of breeding lines and recent releases.

Joseph W. Saunders and LaHong Sheng
USDA - Agricultural Research Service

Cercospora leaf spot evaluations were performed on 10 entries of recent USDA releases and germplasm enhancement lines, some with promising performance in Great Lakes growing areas. The test was designed RCB with 4 replicates of single 30' plots. The test was planted May 3. Emergence was very good. Stands were mechanically thinned June 19. Plots were inoculated with *Cercospora* mid-July, but infection was low until mid-August. From mid-August, the disease progressed quickly. Ratings were done on three dates using a 0 to 10 scale, where 0 was immune (no leaf spot) and 10 was dead (Table 2).

TABLE 2: Mean leaf spot scores for 10 entries.

Entry	16-Aug	24-Aug	12-Sep
EL50	1.8	2.6	2.0
00J02-00	2.3	3.4	3.0
FC709-2	2.4	3.6	4.3
FC727	2.6	4.0	5.8
00J03s03	2.6	4.5	5.7
99J12-01	3.3	4.8	4.0
P915(CA)	3.9	4.9	6.0
SR96	3.9	5.8	5.8
P907(CA)	4.9	5.9	6.0
L19	6.6	7.3	8.0
mean	3.43	4.66	5.07
CV	29.89	15.26	12.22
LSD (0.05)	1.48	1.03	1.05

Genetic Determinants of Seedling Emergence and Vigor in *Beta vulgaris*

Poor seedling emergence is a recurrent problem in sugarbeet production. This problem is related to the lack of vigor among many commercial cultivars. Previous data from replicated field trials were consistent with anecdotal evidence indicating that some varieties have superior emergence potential (McGrath et al., 2000). The biological basis for these differences is quite complex and determined both by the genetics of the seed and by the germination environment. In particular, tolerance to abiotic stresses during the early stages of germination appears to be a major factor that determines the expression of vigor in sugarbeet seedlings.

A simple system that allows comparison of germination in the laboratory under sub-optimal conditions such as hypoxia (submergence), moisture and osmotic stresses (200mM mannitol, 150mM NaCl), and optimal conditions (moist filter paper, 0.3% H_2O_2) predicted the cultivar differences observed under field conditions (Fig. 1). This assay also indicated that H_2O_2 is an inducer of sugarbeet germination particularly under sub-optimal conditions. This system was used as a model to elucidate the molecular and biochemical basis of seedling emergence and to identify candidate genes that contribute to the expression of vigor in *Beta vulgaris*. Our experimental approach includes the use of mRNA differential display and Expressed Sequence Tags (EST) to identify cultivar-specific gene expression patterns that distinguish a good stress-emerger cultivar (USH20) from a poor stress-emerger cultivar (ACH185).

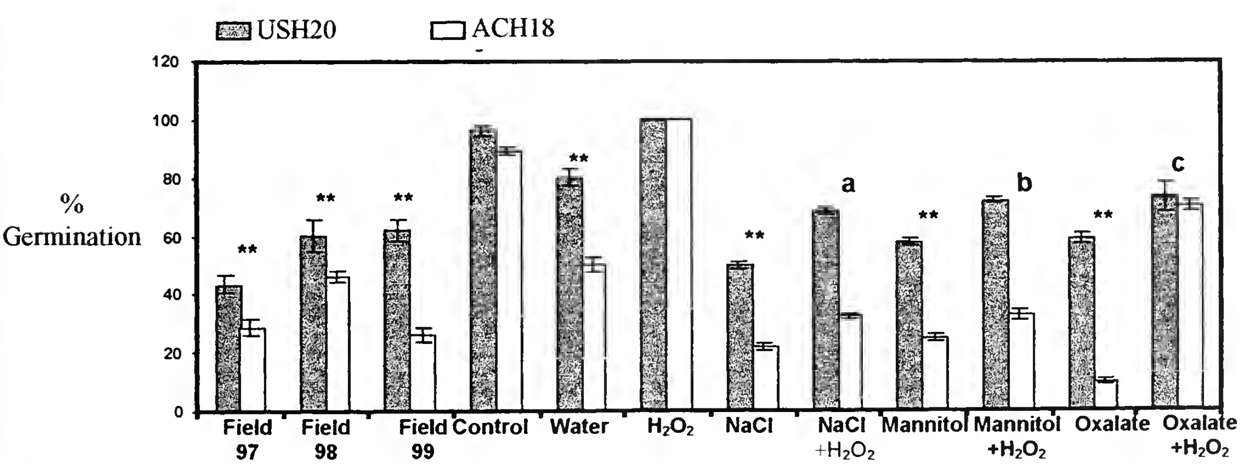
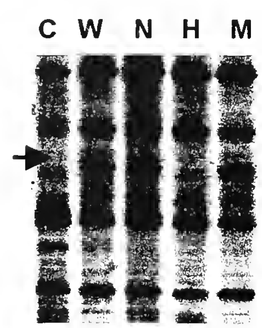


Fig. 1. Germination (%) of two sugarbeet varieties under various regimes. Field data is of 13-15 days after planting (previous and subsequent counts showed same trend). Control is standard germination testing on moist filter paper. ** = significantly different cultivar means ($p \leq 0.01$). a and b = significantly different than NaCl and mannitol treatments alone, respectively. c = USH20 mean not significantly different with oxalate, nor with ACH185 oxalate + H_2O_2.

H_2O_2 is a trigger of seed response to sub-optimal germination environments

Transcript profiling by mRNA differential display indicated both qualitative and quantitative changes in gene expression during germination of USH20 under both optimal and sub-optimal conditions. Based on this analysis, we identified a gene whose expression pattern provides a molecular basis for the observed responses of sugarbeet seedlings to different conditions particularly to low concentration of exogenous H_2O_2. This gene whose expression is highly induced in water, 150mM NaCl and 200mM mannitol solutions, but not in moist filter paper (control) and 0.3% H_2O_2, was identified as a germin (Fig. 2). Three full-length germin cDNA sequence variants were found in the cDNA library constructed from 4-day old stress-germinated USH20 seedlings, indicating that at least three germin genes (*BvGer165*, *BvGer171*, *BvGer172*) are expressed during early seedling growth of *Beta vulgaris*.



a

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HvOxO     MGYSKNLGAGLFTMLLLAP-AIMATDPDPLQDFCVADLDGKAVSVNGH 47
Tagf-2.8  MGYSKTLVAGLFAMLLLAP-AVLATDPDPLQDFCVADLDGKAVSVNGH 47
BvGer165  ------MNNLVVFFSFSVLVC---LSHAIEVDFCVADRS-LPRGPEGY 38
BvGer171  ------MNNLIIFSTFSLLVS---LSHAIEFDFCVGDLS-LPRGPQGY 38
BvGer172  ------MNNLTIFFTFSLLVS---LSHAIEFDFCVGDLN-LPRGPQGY 38

HvOxO     TCKPMSEAGDDFLFSSKLTKAGNTS-TPNGSAVTELDVAEWPGTNTLGV 95
Tagf2.8   TCKPMSEAGDDFLFSSKLAKAGNTS-TPNGSAVTELDVAEWPGTNTLGV 95
BvGer165  ACRDPATLTTDDFVYTGFRGGRTIT-NVPGNNVTLAFVDQFPALNGLGI 86
BvGer171  ACKDPASITTDDFVYTGFRGERTTT-NIFKNNVTLAFADAFPALNGLGI 86
BvGer172  ACKDPANITTDDFVYTGFRGERTTTSNLFRNNVTLAFVDAFPALNGLGI 87

HvOxO     SMNRVDFAPGGTNPPHIHPRATEIGMVMKGELLVGILGSFDSGNKLYS 143
Tagf2.8   SMNRVDFAPGGTNPPHIHPRATEIGIVMKGELLVGILGSLDSGNKLYS 143
BvGer165  SMARLDFGLGGVIPVHSH-RTSEVLIVSRGSIIAGFIDT---NNTAYY 130
Bvger171  SMARLDFGVGGVIPIHSH-RTSEVIILTKGSIIAGFIDT---TNTAYY 130
BvGer172  SMARLDFGVGGVIPIHSH-RTSEVIILATGSIIAGFIDT---TNTAYY 131

HvOxO     RVVRAGETFVIPRGLMHFQFNVGKTEAYMVVSFNSQNPGIVFVPLTLFG192
Tagf-2.8  RVVRAGETFLIPRGLMHFQFNVGKTEASMVVSFNSQNPGIVFVPLTLFG192
BvGer165  RRLEVGDVMIFPQAMLHFQVNVGTTPATAFVSLNGANPAIQFTMNSLFG179
BvGer171  RRLKVGDVMIFPQSMLHFQVNVGKTPATAFVSLNGANPAIQLTTTAIFA179
BvGer172  RRLEVGDVMIFPQAMLHFQVNVGTTPATAFVSLNGANPAIQRTTT-LFA179

HvOxO     SN-PPIPTPVLTKALRVEAGVVELLKSKFAGGS- 224
Tagf-2.8  SN-PPIPTPVLTKALRVEARVVELLKSKFAAGF- 224
BvGer165  GNLPADIAQQITLLSNAEVMRMKRAF-----GTA 208
BvGer171  SNLPADIVDQITLLSNEEVMRLKRIF-----GTA 208
Bvger172  GNLPADIVEQITLLSNE VMRLKRIF-----GTA 208
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b

Fig. 2. (a) Differential regulation of germin (arrow) by stress and H_2O_2. C= control; W=water; N= NaCl; H= H_2O_2; M= mannitol. (b) Alignment of amino acid sequences encoded by *Beta vulgaris* genes (*BvGer165*, *BvGer171*, *BvGer172*) with oxalate oxidase from barley (HvOxO) and wheat (Tagf2.8). Identical residues are shaded in black and similar residues in gray.

Gene-specific expression analysis by reverse transcription-polymerase chain reaction (RT-PCR) showed that only *BvGer165* is induced by stress and repressed by H_2O_2 in the good-emerger USH20. The gene is expressed only at very low levels in the poor-emerger ACH185 (Fig. 3a). This expression pattern is correlated with the ability of low concentrations of H_2O_2 to cause a cultivar-independent enhancement of germination in solution, and to provide partial relief of the negative effect of osmotic and ionic stresses during the process (Fig. 1).

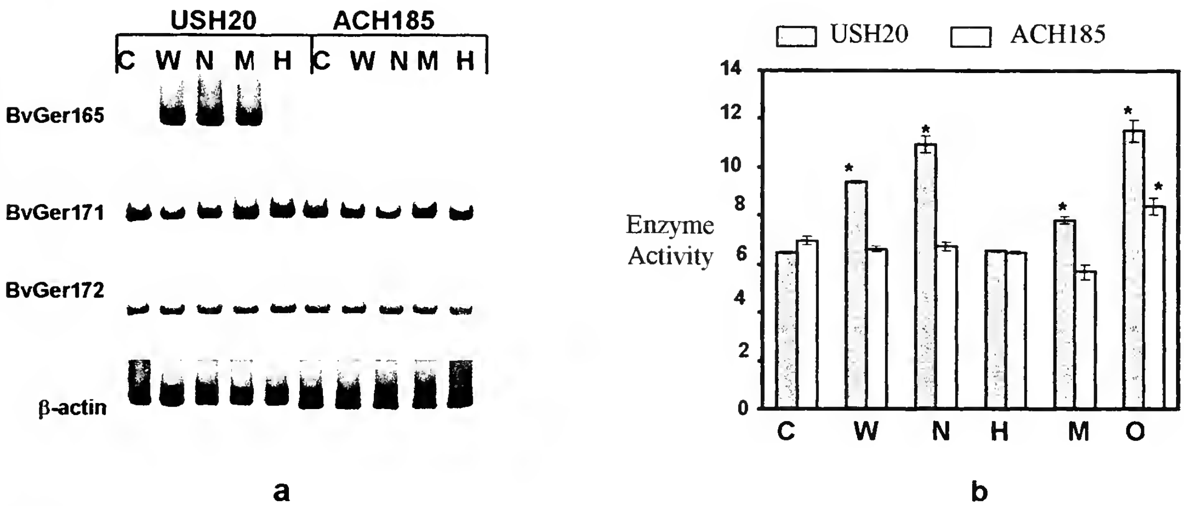

Fig. 3 (a) Gene specific expression analysis of sugarbeet germin genes by RT-PCR. Gene expression control is shown by the constitutively expressed β-actin gene. (b) Oxalate oxidase enzymatic activity (nmole H_2O_2 mg^{-1} protein min^{-1}) in germinating seeds. * Treatments are significantly different from the control ($P \leq 0.001$). C= control;W= water; N= 150mM NaCl; M= 200mM mannitol; H= 0.3% H_2O_2; O= 120mM oxalic acid.

Germin is a homopentameric (125 kDa) cell wall glycoprotein originally identified as a marker of early seedling growth in wheat. Biochemical analysis identified the enzymatic function of germin as an oxalate oxidase by comparison with the barley enzyme (Dumas et al., 1993; Lane et al., 1993). The result of our biochemical assay on sugarbeet seedlings is consistent with the known enzymatic function of germin. Our data showed a significant increase in oxalate oxidase activity in stress-germinated and decrease in H_2O_2-germinated USH20 seedlings (Fig. 3b). This result is parallel with the expression signature of *BvGer165*, thus linking the increase in enzyme activity with the stress-induced expression of this gene.

Oxalate oxidase (oxalate:oxygen oxidoreductase, E.C. 1.2.3.4) catalyzes the oxidation of

oxalic acid by molecular oxygen to produce CO_2 and H_2O_2. Sugarbeet is known to contain moderate levels of oxalic acid (soluble oxalate and insoluble calcium oxalate) in seeds (Miyamoto 1957). Based on this information and from the results of these experiments, it is quite clear that the enzymatic release of H_2O_2 from oxalate is the focal point of germin function during sugarbeet seedling emergence. Exogenous addition of H_2O_2 nullifies the difference observed between USH20 and ACH185 in water germination and partially relieves the negative effect of stress in both cultivars. Furthermore, exogenous H_2O_2 also erased the germination difference between the two cultivars in oxalate solution (120mM) indicating that differences in oxalate level is not the cause of this response but rather the difference in oxalate oxidase activity (Fig. 1). Therefore, the low vigor of ACH185 can be attributed (at least to a certain extent) to its inability to produce endogenous H_2O_2 via the stress-induced expression of *BvGer165*.

Physiological role of germin and H_2O_2 in seedling emergence

It has been suggested that the germin-catalyzed release of H_2O_2 from oxalate is involved in many cellular functions. The H_2O_2 produced from oxalate is utilized in peroxidase-mediated oxidative cross-linking of cell wall polymers and remodeling of the extracellular matrix, which are important in both the initiation and termination of cell wall expansion during the course of water uptake (Lane, 1994 for review; Lane et al., 1992; Jaikaran et al., 1990).

More recent studies strongly support a key role of H_2O_2 as a secondary messenger generated by plants for molecular signaling. This process is important for the transduction of extracellular signals in response to pathogen invasion and sub-optimal environmental conditions (Kovtun et al., 2000; Dat et al., 2000; Desikan et al., 1999; Bartosz, 1997; Foyer et al., 1997; Vallelian-Bindeschendler et al., 1997; Van Camp et al., 1998). Because of this, we propose that germin regulates the developmental expression of other genes with important roles in sugarbeet seedling emergence and stress tolerance via H_2O_2. This hypothesis is supported by both the EST data (Fig. 5) and dot blot hybridization results (data not shown), which showed that stress and exogenous H_2O_2 induce the expression of common set of genes including transcription factors, stress-related proteins, signaling molecules and enzymes involved in energy metabolism. In particular, both the stress and H_2O_2 induce the expression of a number of protein kinases (MAP kinases, protein-tyr kinase/phosphatase), which are known as major components of

phosphorylation cascades in cellular signaling. Similar gene expression profiles between stress- and H_2O_2-germinated seedlings suggest complex and intricate mechanisms of integrating developmental and stress-related responses. This is probably very crucial to seedling success under natural environment. Thus, the germin-mediated production of H_2O_2 appears to be a trigger for the response of USH20 to sub-optimal germination conditions, and this trigger is lacking or blocked in ACH185 (Fig. 4).

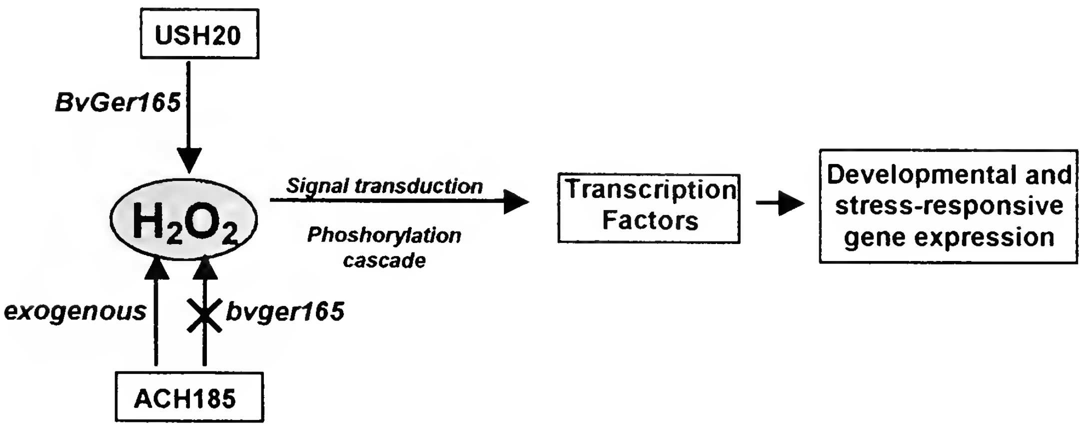

Fig. 4. Hypothetical model for the function of germin/oxalate oxidase and H_2O_2 in the initiation of seedling vigor in *Beta vulgaris*.

Expressed Sequence Tags of *Beta vulgaris*

The complexity of regulatory networks involved in sugarbeet seedling emergence and vigor is apparent from the responses of germination to H_2O_2 and abiotic stresses. Defining and categorizing the range of gene products involved in this process requires global or genome-wide approaches. Expressed Sequence Tags (EST) are powerful genomic tools that involve the cloning and single-pass sequencing of cDNAs. This approach provides a snapshot of total gene activity and biochemical processes occurring in a given plant organ or tissue under different conditions (White et al., 2000). We have initiated a 'small-scale' EST program with the aim of developing the tools for future application of structural and functional genomics for sugarbeet cultivar improvement. The emphasis of this program is on seedling emergence and vigor. Our

goal is to use this EST collection to develop an integrated framework that defines the genetic determinants of seed vigor in sugarbeet.

Our current collection consists of about 1300 ESTs derived from a cDNA library from 4-day old USH20 seedlings (stress- and H_2O_2-germinated seedling cDNAs in lambda Uni-Zap XR vector). The ESTs are divided into three groups defined by three different pools of clones. The first pool consists of about 400 cDNA sequences generated from clones randomly picked from the main library. The second and third groups of ESTs were generated from stress-subtracted (420 clones) and H_2O_2-subtracted (483 clones) libraries, which were constructed through the photobiotin-streptavidin subtraction method (Krady et al., 1990). Hence, the subtracted libraries were assumed to be enriched with cDNA species that are upregulated in response to stress (hypoxia, NaCl, mannitol) and H_2O_2 treatments. About half of our seedling ESTs are now in the public domain (http://www.ncbi.nlm.nih.gov). According to the summary released by GenBank/National Center for Biotechnology Information on March 23, 2001, *Beta vulgaris* has 632 accessions in the dBEST, indicating that our seedling EST collection contributes roughly 90% of the total publicly available ESTs in sugarbeet.

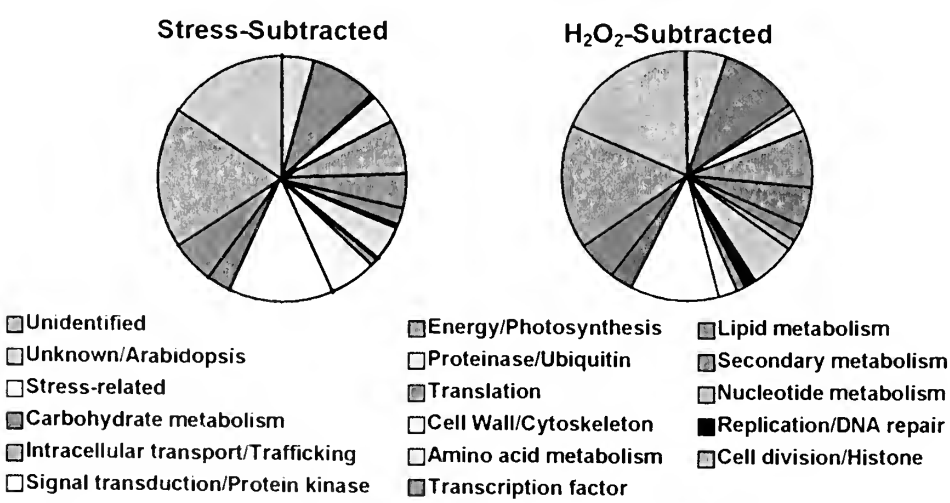

Fig. 5. Distribution of EST classes according to their putative function.

Apparent trends in the sugarbeet stress- and H_2O_2-subtracted EST

The random ESTs gave us a first glance of the range of gene products and metabolic processes that are active in germinating sugarbeet seeds and also allowed a preliminary assessment of the efficiency of our library development and cloning strategies. The relatively small numbers of stress- and H_2O_2-subtracted ESTs that are available to date gave us some meaningful results and suggest possible overlaps and specificity for the stress and H_2O_2 responses during germination (Fig. 5).

In both collections, the largest group of ESTs whose function can be predicted by similarity with known proteins (BlastX, $e \leq 10^{-6}$) is comprise of genes involved in the synthesis of stress-related compounds, proteins and enzymes (heat shock proteins, water stress-associated proteins, disease and wounding-associated proteins, LEA proteins, betaine aldehyde dehydrogenase, trehalose 6-PO_4 synthase, aquaporins or water-channel proteins, glutathione S-transferase, alcohol dehydrogenase, chaperonins). This group is about 13.3% and 12% of the total ESTs in the stress and H_2O_2-subtracted pools respectively. Germin cDNAs were found only in the stress pool, consistent with differential display, northern blot and RT-PCR results.

Other interesting groups include signal transduction molecules (5% in stress and 2% in H_2O_2) and transcription factors (about 2.5% in both stress and H_2O_2). Examples of ESTs under these categories that are found only in the stress pool include DREB2A, AP2-domain proteins, ser-thr protein kinases, protein-tyrosine phosphatase and calreticulin, while those found only in H_2O_2 pool include NAC-domain proteins, homeobox proteins, receptor-like protein kinases and ankyrin. Other transcription factors and signaling genes involved with known developmental and stress-related signaling pathways such as MAPKs, calmodulin, GTP-binding proteins, calcium channel proteins, zinc finger and myb-like proteins were found in both pools. This pattern suggests possible occurrence of common pathways involved in both stress and H_2O_2 signaling during the early stages of germination. This data and the unique occurrence of germin ESTs in the stress pool are consistent with the propose mechanism of action of *BvGer165* and H_2O_2 during the initiation of seedling vigor and emergence in *Beta vulgaris* (Fig. 4).

The highest proportion of ESTs from both stress-subtracted and H_2O_2-subtracted pools cannot be assigned a putative function due to lack of sequence similarity with known genes or proteins. About half of these 'orphan' ESTs (19% in stress and 20% in H_2O_2) are homologous to open reading frames or protein-coding regions predicted from the genome sequence of the model

plant *Arabidopsis thaliana* (The Arabidopsis Genome Initiative, 2000). This data provide an opportunity for discovering novel or germination-specific genes that may provide answers to important questions about the biology of seeds and germination.

Balance of energy and metabolic intermediates during germination

The major sources of energy during sugarbeet germination are not well defined. All three pools of ESTs (random, stress-subtracted and H_2O_2-subtracted) showed high levels of expression of genes encoding starch degrading (α-amylase, α-glucosidase) and glycolytic enzymes (glucose 6- PO_4 dehydrogenase, phosphoglucose isomerase, phosphoglucomutase, triose-PO_4 isomerase, fructose-bisphosphate aldolase, glyceraldehyde 3-PO_4 dehydrogenase). All three libraries are also enriched with cDNAs encoding Tricarboxylic Acid (TCA) cycle enzymes (citrate synthase, aconitase, malate dehydrogenase). Proteinases are also very highly represented in all three pools of ESTs. These findings indicate that energy during germination is provided by the breakdown of stored carbohydrates and probably supplemented by the energy intermediates from storage proteins. However, an interesting discovery from the EST collection is the high level of occurrence of genes encoding enzymes in the glyoxylate cycle (isocitrate lyase, malate synthase, malate dehydrogenase). Isocitrate lyase, the key enzyme that links the glyoxylate and TCA cycles via succinate (Eastmond and Graham, 2001) is one of the most abundant ESTs in the total collection. Another support to the glyoxylate cycle activity is the occurrence of several ESTs for acetyl-CoA acyltransferase, the last key enzyme in beta-oxidation of fatty acids, which provide the substrate (acetyl-CoA) to the glyoxylate cycle. All of these findings indicate that lipids or fatty acids, along with carbohydrates and proteins comprise the reserve energy in sugarbeet seeds.

The glyoxysome, an abundant organelle in oilseeds is the site of the glyoxylate cycle. In oilseeds, this cycle has two important functions. First is the provision of carbon skeletons for carbohydrate synthesis during the early stages of seedling emergence and growth. Second is an anaplerotic pathway that replenishes intermediates that are constantly withdrawn from the TCA cycle for use in biosynthetic reactions (building blocks such as amino acids, nitrogen bases etc.). We therefore hypothesize that the glyoxylate cycle is probably an important component determining seedling emergence and vigor under sub-optimal conditions by virtue of its anaplerotic role for the TCA cycle. The seed requires more energy under stress conditions for use

in growth-related processes, synthesis of building blocks and cellular adjustments to sub-optimal conditions in the germination environment. Cellular adjustment also requires the synthesis of various compounds and metabolites that may be using primary metabolic intermediates as substrates. An important question from this interpretation is whether the glyoxylate cycle is more active in good stress-emerger than in poor stress-emerger cultivar. We are currently investigating this hypothesis by comparing the transcriptional regulation of glyoxylate genes between USH20 and ACH185 under both optimal and sub-optimal conditions.

Prospects

We have identified and characterized a gene (germin or *BvGer165*) that triggers adaptive response of germinating sugarbeet (USH20) to sub-optimal conditions in the laboratory. The apparent lesion in the regulation of this gene in ACH185 indicates that this is one of the major genetic determinants of cultivar differences in vigor or emergence potential. The isolation of *BvGer165* cDNA (GenBank Acc. AF10016) provides a tool to investigate the natural occurrence of this response under field condition at different times and locations. This hypothesis can be tested using simple gene expression profiling techniques (e.g. RT-PCR) on well-characterized germplasm. This study will validate the potential use of this system as a marker to discriminate high emergence potential germplasm. The isolation of BvGer165 cDNA is a step towards cloning the gene. Cloned germin genes will allow identification of promoter motifs/cis-acting elements that can be used to generate allele-specific genetic markers for emergence potential. This system can also be used to identify other genes regulated by H_2O_2 and to elucidate the mechanism of H_2O_2-mediated signal transduction in plants.

Despite of its limited coverage, the current EST collection revealed promising insights on many aspects and molecular events that determine vigor and emergence in sugarbeet. This EST project should open better opportunities for large-scale discovery of genes and metabolic processes critical to seedling emergence. Future application of this tool will include the use of gene array technology for expression profile-based genotyping. This will facilitate a genome-wide approach to dissect the genetic determinants of this complex trait for future use in cultivar improvement by breeding and biotechnology.

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in ungerminated embryos and like germin in germinated embryos, it is incorporated into cell walls. Eur J Biochem 209:961-969.

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AFLP MARKERS FOR THE DEVELOPMENT OF A GENETIC MAP AND FOR MARKER ASSISTED SELECTION IN SUGARBEET

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Introduction:

The efficiency of a Breeding Program depends on the possibility for an early selection of suitable genotypes with accurate methodologies. Marker Assisted Selection (MAS) can be used in early generation selection to screen large populations. The purpose of this work is to develop Amplified Fragments Length Polymorphisms (AFLP) markers from a F_2 population segregating for sucrose content, color of the root tissue and male sterility. These AFLP markers could be integrated with the existing Restriction Fragments Length Polymorphism (RFLP) markers to generate a more detailed genetic map and to find markers associated with the traits of interest.

Methods:

An F_2 segregant population was obtained from the cross between 6869 x W357B lines of *Beta vulgaris*. Line 6869 is a sugarbeet characterized by a higher root sucrose concentration and a green-yellowish color of the root tissue. Differently, W357B is a red beet with lower root sucrose concentration and a dark-red color of the root tissue.

Carbohydrates analysis was performed with High-Pressure Liquid Chromatography (HPLC) on the two parents, the F_1 and 119 F_2 plants. From each plant, a root core section of about 2 g fresh-weight was collected at 3 cm below the crown. After liophylization, sucrose was extracted with 80% ethanol solution and dried. The pellet was suspended in sterile distilled water and injected into the HPLC.

The genetic analysis of the segregant population was performed with the AFLP technique on an Automated DNA Sequencer (LICOR 4200). The protocol of Vos et al. (1995) was adopted with minor modifications. One hundred ng of genomic DNA was digested with a pair of restriction enzymes and ligated with the appropriate adapters. Two different pairs of restriction enzymes were used: EcoRI/MseI and PstI/MseI. For each enzyme, the following selective nucleotide sequences were used during the PCR selective amplification:

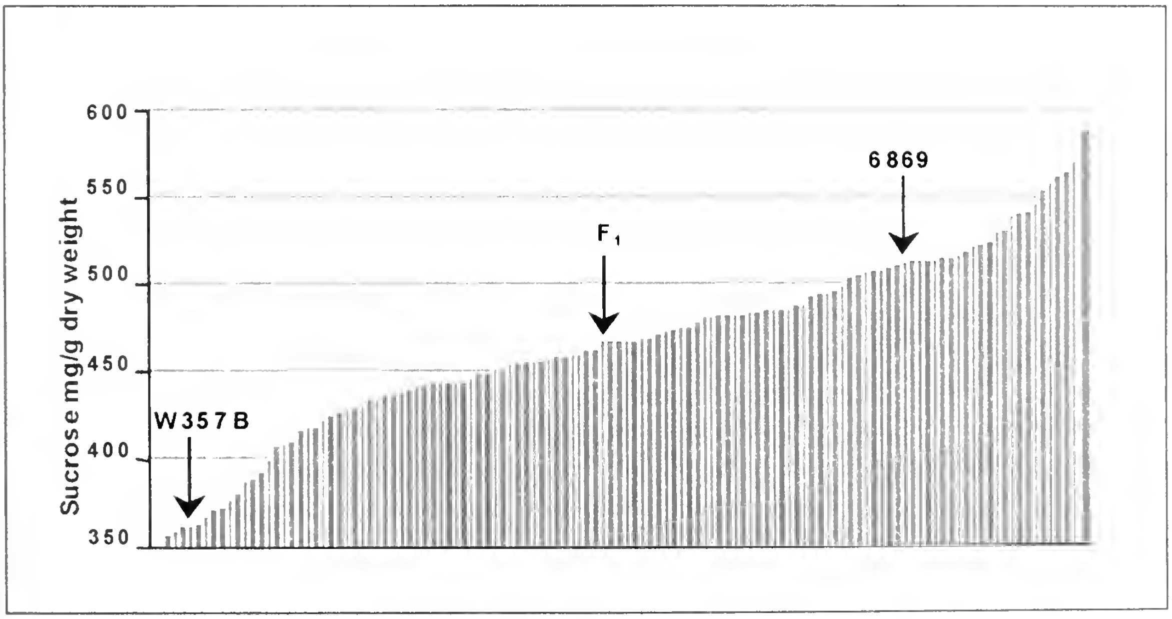
- EcoRI: +ACT and +ACA
- PstI: +CA
- MseI: +CGG, +CAT, +CAG and +CTT.

The EcoRI and PstI selective primers were labeled with fluorescent dyes (LI-COR IRD700 and IRD800) to allow the detection of the fragments in the Automated DNA Sequencer. A 6.5% acrylamide gel electrophoresis was use to separate the bands and the polymorphic fragments were analyzed for their 3:1 segregation ratio.

Results:

In the F_2 population of 119 plants, sucrose content was between 355 and 588 mg per g of root dry-weight (Fig. 1), while only traces of other carbohydrates, such as glucose, were detected (data not shown). Trasgressive segregation was present at high sucrose contents, reaching 115% of the 6869 parent. Considering the root tissue color, F_2 plants segregates in the proportion 90:29 for red to green-yellowish phenotypes, respectively, consistent with a 3:1 segregation ratio as expected ($X^2 = 0.02521$; $P = 0.9$).

Figure 1: Segregation of sucrose content in the F_2 plants. The red or green colors of the bars represent the root tissue phenotype of each plant. Sucrose content and root tissue phenotype of the two parental lines (W357B and 6869) and F_1 hybrid are marked with arrows.



The AFLP primers combinations showed a number of total fragments ranging from 40 to 70 for each one of the EcoRI/MseI combinations and from 70 to 110 for each one of the PstI/MseI combinations. The number of polymorphic fragments ranged from 5 to more than 20% of the total fragments in EcoRI/MseI and from 2 to 10% in PstI/MseI combinations (Fig. 2). Analysis of polymorphic fragments in the EcoRI+ACT/MseI+CTT combinations revealed that 6 out of 11 of them segregate in a 3:1 ratio for presence to absence of the fragment, respectively.

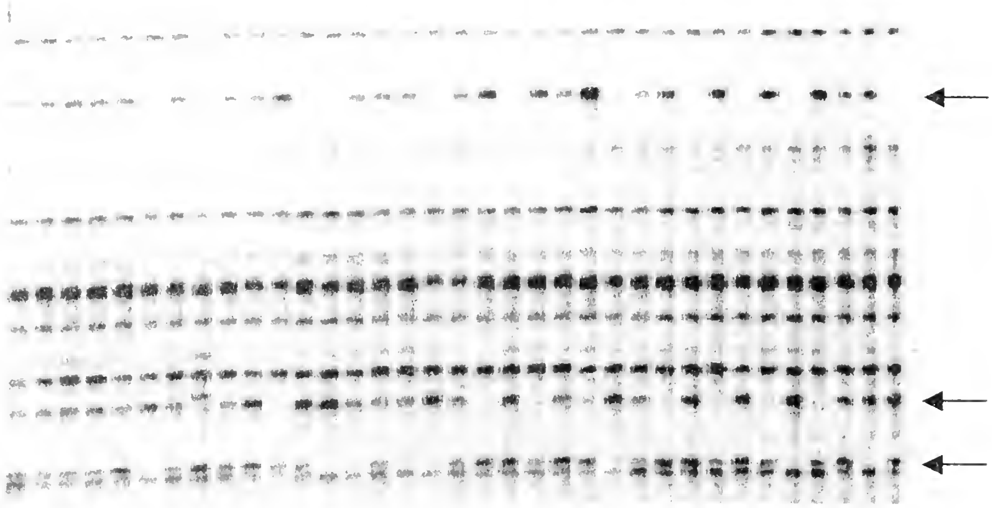


Figure 2: Detail of an AFLP gel electrophoresis showing three polymorphic fragments (arrows).

Discussion and future work:

The continuous distribution of the sucrose content in the segregant population, and the location of the F_1 plant (467 mg g^{-1} DW) between the two parental lines (510 and 365 mg g^{-1} DW for 6869 and W357B, respectively), explains the quantitative inheritance and the absence of main dominance effects for this trait. Differently, the 3:1 segregation ratio of the root tissue color trait may be explained by the presence of a single dominant gene for the red phenotype. Interesting 17 out of 20 plants that had the highest sucrose content, showed a red phenotype. Further analysis will determine the segregation ratio and inheritance of the male sterility trait in this population.

The AFLP analysis is under going in our laboratory and we will expect to detect a total of 30 to 80 informative polymorphic fragments from the actual 12 possible selective nucleotide sequence combinations. Furthermore, others 55 EcoRI/MseI and PstI/MseI combinations will be analyzed to increase the number of informative polymorphisms. These AFLP polymorphisms will be integrated with other existing RFLP markers to originate a sugarbeet genetic map. A linkage analysis will be performed to detect markers linked to the traits of interest that could be used for a future MAS.

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A novel method to evaluate Aphanomyces disease resistance

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Introduction

Aphanomyces cochlioide causes damping-off at the seedling stage, and black root in mature plant. As a seedling disease, it has been considered one of the main reasons for poor establishment in the fields (Coons et al. 1946). Zoospores of *A. cochlioides*, generally 7-11um in diameter, may swim a limited distance in soil (normally less than 50 cm), and then adhere to sugar beet root surfaces and form cysts. Zoospores are very sensitive to their environment, especially to high salt concentration and bivalent cations. Adverse conditions result in rapid encysting. Cysts can either form zoospores, or produce germ tubes, which can penetrate into plant tissues. *A. cochlioides* is capable of repeated zoospore dispersal from germinating zoosporangia or cysts (Cerenius and Soderhall 1985). Both sporangium formation and zoospore dispersal require unbound water. Oospores are produced inside infected plant tissues. Cysts and oospores may survive for several years in soil, weed hosts, and infected plant debris. Disease intensity is more severe under high moisture and warm temperature. Seedlings are seldom infected below 15 °C (Windels and Jones, 1989).

All commercial sugar beet varieties are affected by this seedling disease, albeit at various levels (Afanasiev 1956). A fundamental control for *Aphanomyces* has been resistance breeding. However, laboratory experimental evaluation of resistance has been problematic. Greenhouse tests for resistance have been reported (e.g. Schneider and Hogaboam 1983), but this approach is inconsistent in practice. Our group is evaluating resistance in a petri-dish system, which appears to give more consistent results.

Materials and Methods

Materials used were Beta16AB (from Betaseed, *Aphanomyces* susceptible check), EL48 and USH20 (two moderately resistant lines).

The petri-dish inoculation process was:

1. Seeds were surface sterilized using 15% Clorox for 20 min, then washed with sterile distilled water for three times. Seeds were then incubated in 0.3% hydrogen peroxide with shaking (75rpm) at room temperature for one to two days, then transferred into distilled waster to continue incubation. After radical emergence, seedlings were transferred to petri-dish (diameter: 100 mm, deep dish, Falcon). Plants were checked frequently, and contaminated seedlings were removed. Two-to-three week old seedlings were used in inoculation.

2. One week after seed germination, fresh *Aphanomyces* (a Michigan isolate, courtesy of David Johnson) mycelium blocks (from CMA plate, CMA: Corn meal agar, Sigma) were transferred into 50-70 ml CMA liquid solution (17g/L, filter and retain liquid part, autoclave 15 min) in 125ml flasks, and incubated in the dark at 25 °C. One day before inoculation, mycelia were transferred into the proper amount (1/3 to half volume of original CMA solution) of SP solution (Sodium chloride and potassium chloride solution, NaCl 5mg/L and KCl 1mg/L in millipore water) for one day in the dark, shaking the solution slightly to make

a loose spread of mycelia.

3. Zoospore concentration was estimated using haemocytometer, and zoospore solution was diluted with SP to a final concentration of 200 zoospores/ml for inoculation (inoculum).
4. Each petri-dish contained about 25 plants, with 3 replications of each variety. After decanting original culture water, 20 ml inoculum was dispensed into each dish. During the dispensing process, stock inoculum was shaken gently and frequently to maintain an equal density of zoospores. Evenly distribution of the inoculum into each dish was critical for the experiment.
5. Plants were incubated in the dark for 2 hours at 26 (±1) °C. Inoculum was then decanted from the petri-dish. Plates were rinsed briefly with Millipore water (15 to 20 ml), then decanted. Finally, about 15 ml distilled water was added to each plate to keep roots covered. Plants were grown under light.
6. Numbers of healthy hypocotyls and healthy cotyledons were recorded from the third day to the fifth day.

Results

The results of healthy hypocotyl and cotyledon ratio after inoculation were shown in Table 1.

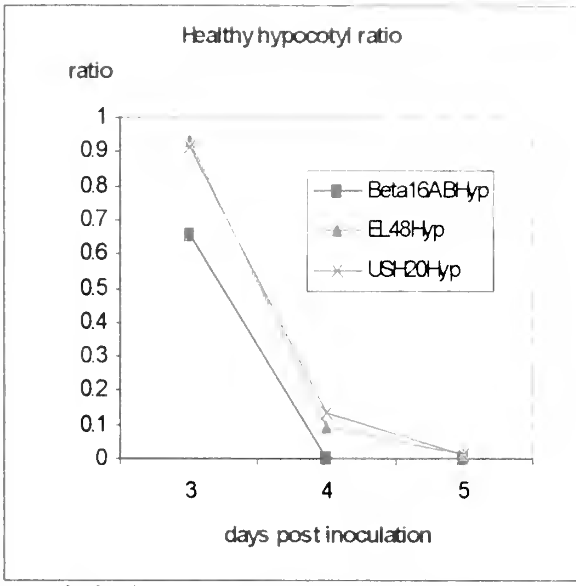
Table 1. Petri-dish inoculation to evaluate Aphanomyces disease resistance

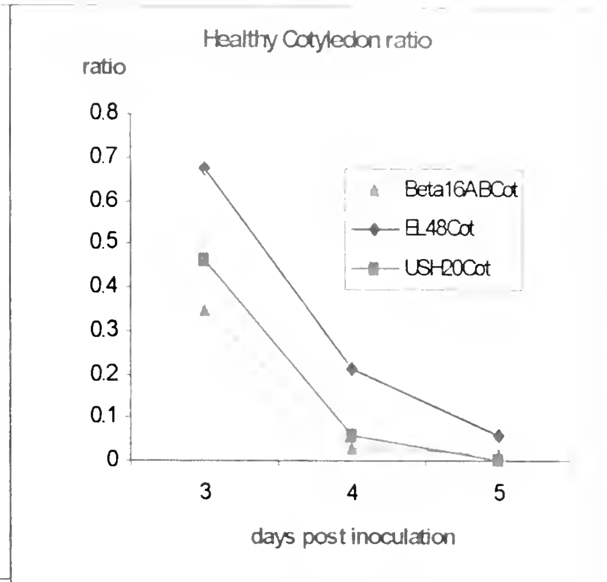
Variety	Total plants	Healthy Hyp D3 (%)	Healthy Hyp D4 (%)	Healthy Hyp D5 (%)	Healthy Cot D3 (%)	Healthy Cot D4 (%)	Healthy Cot D5 (%)
Beta16AB	25	60	0	0	36	4	4
Beta16AB	24	71	0	0	42	4	0
Beta16AB	23	65	0	0	26	0	0
	means	65	0	0	35	3	1
	SD	5	0	0	8	2	2
EL48	30	90	3	3	60	17	3
EL48	30	93	10	0	70	27	7
EL48	29	97	14	0	72	21	6
	means	93	9	1	67	21	6
	SD	3	5	2	7	5	2
USH20	22	91	18	0	55	5	0
USH20	23	87	4	0	39	4	0
USH20	22	95	18	5	45	9	0
	means	91	13	2	46	6	0
	SD	4	8	3	8	3	0
Overall means		83	7	1	49	10	2

Notes: Healthy Hyp D3(%) =(number of healthy hypocotyls on day 3 / total number of plants) X 100. Healthy Cot D4(%) =(number of plants with healthy cotyledons on day 4 / total number of plants) X 100.

The means of healthy hypocotyl and cotyledon ratios were plotted against days after inoculation, as shown in Figure 1. Healthy hypocotyl and healthy cotyledon ratios were greatly reduced from the third day to the fourth day. EL48 had the best performance, either in the healthy to total hypocotyl ratio or healthy to total cotyledon ratio.

Figure 1. Means of healthy hypocotyl and cotyledon ratio post Aphanomyces inoculation.





Statistical analyses (SAS) for the healthy hypocotyls ratio on the third day showed that USH20 and EL48 were significantly less diseased than Beta16AB ($P=0.0009$ and $P=0.0006$, respectively). No Statistical significance was observed between USH20 and EL48 ($P=0.8209$), indicating petri-dish inoculation method provides constant estimate of disease resistance.

Discussion

We tried a number of laboratory inoculation protocols, including soil inoculation and detached leaf assays, without success. We concluded that *Aphanomyces* zoospores are very sensitive to the environment (Cerenius and Soderhall, 1985), especially salt concentration, and form cysts quickly under adverse conditions. Thus the contact of zoospores with roots is not even among different plants, creating significant environmental error that greatly reduces the statistical discerning power. Also, *Aphanomyces* hyphae are not very active in the soil, and may be colonized bacteria, as bacteria were observed colonizing inside the hyphae. Thus, hyphal growth faces competition from other organisms, which may inhibit infection (Williams and Asher 1996). Even though our soil was autoclaved to reduce environmental error, seedlings contaminated with fungi or bacteria were observed. With the petri-dish system, we were able to reduce environmental interference. Reducing error benefited statistical analyses.

Temperature appears to be an important factor for this resistance assay, since *Aphanomyces* favors warm temperatures. At high temperature (e.g. 30 °C), disease developed much faster. More plants were infected in inoculations performed at 30 °C than at 20 °C, and the symptoms developed faster (data not shown). There were few symptoms for inoculations conducted below 15-17 °C. This result was consistent with the report of Windels and Jones (1989).

Different *Aphanomyces* isolates have varied ability to generate zoospores. Isolates with fast growth rates tend to have a good yield of zoospores. Blocks of *Aphanomyces* transferred into CMA broth should be fresh, less than 4 days old. Blocks should be cut from the growing edge of mycelia, which have active zoospore generation ability. Old mycelia seem to lose this ability. The zoospore production ability may be lost after generations of culture. An effective approach is to use mycelia to infect *in-vitro* cultured and aseptic seedlings, then re-isolate mycelia from

infected plants. Isolates can be purified by growing mycelia germinated from single zoospore.

Scoring cotyledons was not considered reliable. From the data of healthy cotyledon ratio, we found no statistical difference between USH20 and Beta16AB. One of the reasons that EL48 had the highest healthy cotyledon ratio was that cotyledons of EL48 plants had little contact with inoculum. It seems that cotyledon was vulnerable to *Aphanomyces* infection, which was a reason for the failure of detached leaf assays. In order to obtain better estimate of disease resistance, avoiding contact of cotyledon with inoculum is reasonable.

A critical part of petri-dish inoculation is to keep zoospores actively swimming. It is crucial to confirm the density of swimming zoospore inoculum just before inoculation. We have compared the effects of different suspension solutions. SP solution with final concentrations of NaCl 5 mg/L and KCl 1 mg/L gave the best result. Using SP solution, *A. cochlioides* had stable and abundant zoospore production. Some zoospores remained active up to 5 days in SP solution. SP solution with higher or lower salt concentrations did not work well. Solutions with NaCl only or Millipore water had adverse effect on zoospore activity. Distilled water worked well, but water quality varies, leading to inconsistencies in zoospore production.

Another critical part of this assay is the use of hydrogen peroxide for germinating seeds. In other experiments (De los Reyes & McGrath, this volume), we have demonstrated that hydrogen peroxide induces a series of defense-related gene products that would be involved in response to pathogenesis. Such an induction also appears to remove a strong seedling vigor component in resistance by inducing the battery of 'vigor' genes after hydrogen peroxide steeping.

Based on our study, we believe petri-dish inoculation appears to be a practical approach to evaluate *Aphanomyces* seedling disease resistance in the lab. We are testing this system on a mapping population to examine inheritance of resistance in this assay, which will further corroborate our interpretations to date.

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SUGAR BEET RESEARCH

2000 REPORT

Section F

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This research was supported in part by funds provided through the Beet Sugar Development Foundation (Projects 810, 811, 831 and 850)

CONTENTS

PUBLICATIONS

Ivic, S., R. Sicher and A. Smigocki. Growth habit and sugar accumulation in sugarbeet (*Beta vulgaris* L.) transformed with a cytokinin biosynthesis gene. Plant Cell Reports (submitted)

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Ivic, S., J. Saunders and A.C. Smigocki. Leaf disc callus from sugar beet breeding lines for biolistic transformation. American Society for Sugar Beet Technologists. February, 2001, p. 20.

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Selected abstracts of papers published or approved for publication:

GROWTH HABIT AND SUGAR ACCUMULATION IN SUGARBEET (*BETA VULGARIS* L.) TRANSFORMED WITH A CYTOKININ BIOSYNTHESIS GENE. S. D. Ivic [1] R. C. Sicher [2] A. C. Smigocki [1] [1]Molecular Plant Pathology Laboratory and [2]Climate Stress Laboratory, United States Department Of Agriculture, Agricultural Research Service, Beltsville, MD 20705, USA

Expression of a bacterial cytokinin biosynthesis gene fused to a patatin gene promoter was studied in sugarbeet (*Beta vulgaris* L.). Two independent transformants, Pat-*ipt* 1 and 2, exhibited a number of distinguishable morphological alterations commonly induced by cytokinins, i.e. less root growth, reduced leaf surface area and increased axillary shoot development. Concentrations of the cytokinins zeatin and zeatin riboside were increased by 2- and up to 18-fold in taproots and leaves, respectively. Leaf sucrose and glucose concentrations were not significantly different from those in control plants except in Pat-*ipt* 2 where glucose levels were elevated 9-fold. Since normal taproot development was severely inhibited, sucrose concentrations in the taproots were significantly reduced.

LEAF DISC CALLUS FROM SUGARBEET BREEDING LINES FOR BIOLISTIC TRANSFORMATION. Snezana D. Ivic [1*], Joseph W. Saunders [2], and Ann C. Smigocki [1], [1]USDA, ARS, Molecular Plant Pathology Laboratory, Beltsville MD 20705, and [2]USDA, ARS, Dept. of Crop and Soil Sciences, Michigan State University, East Lansing MI 48824.

A particle bombardment method for introducing foreign genes into sugarbeet was developed in this lab (Snyder et al. 1999). This method is based on the use of hypocotyls as a source of embryogenic callus for the transformation step. This is a lengthy protocol that requires a 3-week seed germination period followed by a hypocotyl cultivation period of 6 to 8 weeks. Seed germination is often hampered by persistent fungal contamination and the hypocotyl isolation is time consuming. Transformation frequencies obtained with embryogenic hypocotyl callus from a noncommercial line, REL-1, were low. We explored alternative sources of embryogenic sugarbeet callus for using with the particle bombardment method for sugarbeet transformation.

EVALUATION OF THE BIOLISTIC TRANSFORMATION METHOD FOR COMMERCIALLY IMPORTANT SUGARBEET BREEDING LINES. Snezana D. Ivic and Ann C. Smigocki, USDA, Agricultural Research Service, Molecular Plant Pathology Laboratory, Beltsville MD 20705

Conventional breeding of sugarbeet is difficult since it is a biennial and a highly heterozygous plant. Genetic improvement of sugarbeet using biotechnology has progressed slowly since currently available methods of transformation (D'Halluin et al., 1992; Hall et al., 1996; Krens et al., 1996; Lindsey et Galloi, 1990) are not readily

reproducible or cultivar independent. A biolistic sugarbeet transformation method (Snyder et al. 1999) was developed in this laboratory using embryogenic hypocotyl callus of a tissue culture clone REL-1. This clone has high regeneration potential *in vitro*; however, it is not suitable as a breeding line for rapid genetic improvement of commercially important sugarbeet lines. Therefore, we tested the feasibility of using the biolistic transformation method with several commercially important sugarbeet breeding lines.

GENE TRANSFER TO SUGARBEET FOR IMPROVED RESISTANCE TO THE SUGARBEET ROOT MAGGOT (*Tetanops myopaeformis* Roder). Ann C. Smigocki, Molecular Plant Pathology Laboratory, USDA/ARS, Beltsville, MD 20705

One of the most devastating pests of sugarbeet in the US is the root maggot (*Tetanops myopaeformis* Roder). Losses can be higher than 20% in infested fields and are speculated to increase in the next few years due to the anticipated removal of chemical pesticides effective against the maggot from EPA approved registrations. Currently no biological control measures are available. Introduction of multiple resistance genes into transgenic plants will most likely prove to be the most effective and perhaps sustained means of controlling diseases and insect infestations. Stable incorporation of beneficial genes into sugarbeet has been hampered by a lack of reproducible transformation methods. We are employing one of two transformation methods developed in this laboratory to introduce beneficial genes for insect control into sugarbeet. Two approaches are being undertaken for management of the sugarbeet root maggot (SBRM). One approach involves the expression in transgenic sugarbeet plants of proteinase inhibitor genes to specifically target the digestive proteases leading to inhibition of catalysis of dietary proteins essential for normal insect growth and development. We have determined the nature of the maggot's digestive proteases in midgut extracts prepared from feeding second instars using an inhibition assay. Two classes of proteinase inhibitors specifically inhibited most of the gut protease activity. Another approach being evaluated is the effect of cytokinin-induced insecticidal compounds on the SBRM larvae. A 0.1 and 1% suspension of extracts from leaf surfaces of *Nicotiana plumbaginifolia* plants transformed with a cytokinin biosynthesis gene induced a twitching response and death of 30% of first instar SBRM larvae after a 72 hr exposure. More than 90% of the larvae were dead as compared to about 25% of the controls after 120 hr. Sugarbeet plants transformed with a cytokinin biosynthesis gene fused to a wound-inducible or a tuber-specific promoter have been regenerated for further analysis of the effect of cytokinins on defense responses.

GENETIC ENGINEERING FOR ROOT MAGGOT CONTROL. Ann Smigocki, Molecular Plant Pathology Laboratory, USDA, ARS, Beltsville, MD.

The sugar beet root maggot (SBRM), *Tetanops myopaeformis*, was first described as a sugar beet pest in Utah in the 1920's. It is now considered the major sugar beet pest of the central and western sugar-beet-growing areas in the United States and Canada. Of the

1.5 million acres of sugar beet grown annually, nearly half are infested with the root maggot. The maggot inflicts significant crop damage and yield losses that can range from 10 to 100% in infested fields. An adult fly can lay as many as 200 eggs around the base of a sugar beet seedling during late May and June. As the eggs hatch, the developing maggots feed on tap and feeder roots throughout the growing season and either completely sever the roots of seedlings or badly scar the larger roots. Granular pesticides of the carbamate or organophosphate classes are often used to reduce larval populations in sugar beet fields. With the re-evaluation of pesticides mandated by the Food Quality Protection Act of 1996, the potential for loss of insecticides is real and alternatives few. Cultural control practices, such as crop rotation, have been ineffective mainly due to the mobility of the adult flies. Existence of several weed species as substitute hosts has also hindered population control. Thus, we need to explore alternative strategies for improved control of the maggot. By analyzing the content of excised stomachs from feeding root maggots, we have identified two major classes of digestive enzymes as targets for control. Next step will involve selection of effective inhibitors and reengineering of their respective genes for efficient production in the sugar beet root. To assist us with the genetic engineering of sugar beet, we have developed gene transfer methods that we are currently optimizing and testing on commercially important sugar beet breeding lines. In the near future, we plan to incorporate the inhibitor genes into sugar beet chromosomes for targeted, more environmentally compatible, control of the root maggot.

INHIBITION OF ASPARTYL AND SERINE PROTEINASES IN THE MIDGUT OF SUGARBEET ROOT MAGGOT WITH BIOCHEMICAL AND PLANT-DERIVED PROTEINASE INHIBITORS. Stephen E. Wilhite[1], Thomas C. Elden[1], Borut Strukelj[2], Scott Armstrong[3], and Ann C. Smigocki[4] [1]Soybean and Alfalfa Research Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, MD 20705, USA, [2]Department of Biochemistry and Molecular Biology, Jozef Stefan Institute, Jamova 39, SI-1000, Ljubljana, Slovenia, [3]Plant and Soil Sciences Department, Texas Tech University, Lubbock, TX 79409, USA, [4]Molecular Plant Pathology Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, MD 20705, USA.

The use of genes encoding proteinase inhibitors (PIs) to transform crop plants for resistance to insect pests (see Jouanin et al., 1998, and; Schuler, et al., 1998, for reviews) may represent an alternative approach to insect control. PIs occur naturally in a number of plant species and are likely a part of the natural defense mechanism against insects (Green & Ryan, 1972). PIs specifically bind and inhibit the action of digestive proteinases in the insect midgut, thereby exerting a deleterious effect on insect growth and development (Jongsma & Bolter, 1997, for review). Due to significant variation in the types and properties of proteinases utilized by insects for dietary purposes (see Terra & Ferreira, 1994, for a review), and the altered specificity that plant PIs possess toward such proteinases (Keilova & Tomasek, 1976; Abe et al., 1994; Brzin et al., 1998; Christeller et al., 1998; Pernas et al., 1998), it is necessary to characterize the proteolytic activities of each individual pest species in order to devise a rational control strategy. The present study examines the effect of pH, low-molecular weight inhibitors, and plant-

derived PIs on general substrate hydrolysis to identify the major midgut proteinases of the SBRM.

MODULATION OF CYTOCHROME P450 GENE EXPRESSION BY CYTOKININS AND WOUNDING. Cesar Mujer, and Ann Smigocki. Molecular Plant Pathology Laboratory, ARS, USDA, Beltsville, MD 20705

A Nicotiana plumbaginifolia cDNA clone, CYP72A2, with high sequence similarity to cytochrome P450 monooxygenases was isolated using reverse transcription-polymerase chain reaction. CYP72A2 has an open reading frame of 1524 nucleotides and belongs to a small gene family. Its deduced 508 amino acid sequence shares 45% identity with the Catharanthus roseus cytochrome P450 CYP72A1 that has been tentatively assigned as geraniol-10-hydroxylase, an enzyme that catalyzes the conversion of geraniol to 10-hydroxygeraniol, the rate limiting step in the biosynthesis of the monoterpene alkaloids camptothecin, vinblastine and vincristine. Mechanical wounding, insect chewing (Manduca sexta) and cytokinin application were shown to induce CYP72A2 expression. A higher level and more rapid induction of CYP72A2 transcripts was observed in N. plumbaginifolia plants transformed with a wound-inducible cytokinin biosynthesis gene construct (PI-II-ipt) as compared to controls. Mechanical wounding of the PI-II-ipt leaves induced a 6-fold increase of CYP72A2 messages at 6 h in comparison to only a 2-fold induction observed after 12 h in untransformed plants. A similar response was observed when plants were sprayed with either 5 x 10^{-6} M zeatin or when M. sexta larvae fed on the leaves. The up-regulation of the CYP72A2 transcripts in response to insect or mechanical wounding was systemic. Polyclonal antibodies specific for three internal regions of the deduced CYP72A2 protein cross-reacted with a 58.8 kDa polypeptide that accumulated in response to wounding. Functional studies are in progress to determine if CYP72A2 has geraniol-10-hydroxylase activity. In addition, sense and antisense gene constructs have been introduced into N. tabacum for structure-function analysis. The modulation of CYP72A2 expression by cytokinins and its possible role in plant defense responses will be discussed.

TOMATO (*Lycopersicon esculentum* Mill.) TRANSFORMANTS CARRING *ipt* GENE FUSED TO HEAT-SHOCK (*hsp70*) PROMOTER.

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Tomato *ls* mutant, characterised by suppressed lateral shoots, abnormal flowers and low level of endogenous cytokinins, was transformed with *Agrobacterium tumefaciens* strain ACS101 carrying an *ipt* gene under a heat shock promoter. Of the 62 rooted shoots that were obtained, most exhibited unchanged ploidy levels. PCR analysis confirmed that 76% of the plants were transgenic. Segregation of the selectable marker gene, *nptII*, in

majority of the progeny was 3:1 on kanamycin-containing medium. Heat shock treatment at 42°C for 2 hr increased *ipt* gene transcripts as analyzed by RT PCR. Transcript levels decreased over time and after six hours could not be detected.

WOUND-INDUCIBLE CYTOCHROME P450 FROM NICOTIANA PLUMBAGINIFOLIA. Cesar V. Mujer and Ann C. Smigocki Molecular Plant Pathology Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, MD 20705, USA.

Two Nicotiana plumbaginifolia cDNA clones, CYP72A2 and npl2, with high sequence similarity to cytochrome P450 monooxygenases were isolated using reverse transcription-polymerase chain reaction. CYP72A2 has an open reading frame of 1524 nucleotides and its deduced 508 amino acid sequence has 45% identity to Catharanthus roseus P450 CYP72A1. npl2 is similar to CYP72A2 except for an 82-nucleotide deletion within its coding region and an internal stop codon. Southern blot analysis indicated that there are at least three copies of the CYP72A2 gene and that they are induced by mechanical wounding, insect chewing (Manduca sexta) and cytokinin application. In N. plumbaginifolia plants transformed with a wound-inducible cytokinin biosynthesis gene construct (PI-II-ipt), mechanical wounding of the leaves induced a 6-fold increase of CYP72A2 messages at 6 h in comparison to a 2-fold induction after 12 h in wounded, untransformed leaves. A similar response was observed when plants were sprayed with 5 x 10^{-5} or 5 x 10^{-6} M zeatin or when M. sexta larvae fed on the leaves. The response to feeding larvae and wounding was systemic. Using polyclonal antibodies raised against three internal regions of the deduced CYP72A2 protein, a 58.8 kDa polypeptide was detected in leaves of N. plumbaginifolia as well as in the leaves of 4 other plant species. The modulation of CYP72A2 expression by cytokinins and the possible role of P450 in plant defense responses are discussed.

A WOUND INDUCIBLE CYTOCHROME P450 FROM TOMATO. Grzegorz Bartoszewski[1*], Cesar V.Mujer[2], Katarzyna Niemirowicz-Szczytt[1], Ann C. Smigocki[2], [1] Department of Plant Genetics, Breeding and Biotechnology Warsaw Agricultural University, Warsaw, Poland; [2] U.S. Department of Agriculture, Agricultural Research Service, Molecular Plant Pathology Laboratory, Beltsville, MD 20705, USA

A cDNA clone sharing high sequence similarity to *Nicotiana plumbaginifolia* cytochrome P450 monooxygenase was cloned from *Lycopersicon esculentum cv.* 'Rutgers'. The tomato cDNA has a full open reading frame and 75% protein sequence identity to *Nicotiana plumbaginifolia* P450 (CYP72A2) that is wound- and cytokinin-inducible. Its genomic sequence contains 3 short introns. Expression of the P450 gene was highest in young tissues. Leaf transcript levels increased in response to mechanical wounding but applications of the cytokinin zeatin had no effect on the tomato P450 gene expression.

WOUND INDUCTION OF A TOMATO GENE ENCODING A PROTEIN SIMILAR TO A CYTOCHROME P450 ENZYME. Grzegorz Bartoszewski [1)], Cesar V. Mujer [2)], Katarzyna Niemirowicz-Szczytt [1)], Ann C. Smigocki [2)], 1)Department of Plant Genetics, Breeding and Biotechnology, Faculty of Horticulture and Landscape Architecture, Warsaw Agricultural University, Warsaw, Poland; 2) Molecular Plant Pathology Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, MD 20705, USA

A *Lycopersicon esculentum* cv Rutgers cDNA clone with high similarity to a *Nicotiana plumbaginifolia* putative cytochrome P450 monooxygenase was isolated using 5' and 3' RACE. The isolated cDNA (GenBank Accession No. U35226) has an open reading frame of 1494 bp and encodes a protein of 498 amino acids. The deduced protein sequence has 75% identity to the *N. plumbaginifolia* P450 (CYP72A2) and 41% to the *Catharanthus roseus* CYP72A1. The genomic P450 sequence obtained by PCR was shown to contain three short introns. Southern (-) blot analysis revealed 2 highly homologous genes in the tomato genome. Expression of the P450 clone in mature leaves is regulated by circadian rhythm and enhanced by wounding. Leaf transcript levels were highest 3 hr after mechanical wounding. Expression of cloned gene is tissue specific with highest levels of expression in the shoot tips and in young leaves and fruits. Zeatin application and uptake experiments did not increase the expression of the tomato P450 gene. The function of this gene is presently not known.

CLONING OF A TOMATO CDNA SEQUENCE ENCODING A PROTEIN SIMILAR TO A CYTOCHROME P450 ENZYME. Grzegorz Bartoszewski[1], Cesar V.Mujer[2], Katarzyna Niemirowicz-Szczytt[1], Ann C. Smigocki[2], [1] Departament of Plant Genetics, Breeding and Biotechnology, Warsaw Agricultural University, Warsaw, Poland and [2] U.S. Departament of Agriculture, MPPL, Beltsville, MD 20705, USA

cDNA clone with high similarity to *Nicotiana.plumbaginifolia* putative cytochrome P450 monooxygenase was isolated using 5' and 3' RACE from *Lycopersicon esculentum cv.*'Rutgers'. Isolated cDNA has an open reading frame of 1494 and its deduced protein sequence has 75% identity to *Nicotiana.plumbaginifolia* P450 (CYP72A2). Genomic P450 sequence contains 3 short introns. The highest level of mRNA of tomato was observed in shoot tip, young leaf and young fruit. Transript level of tomato P450 was increased after mechanical wounding in tomato leaves. Zeatin spray and zeatin uptake doesn't effect tomato P450 expression.

Gene Transfer to Optimize the Sucrose Storage Capacity of the Sugarbeet Taproot

BSDF Project 810

Ann C. Smigocki and Snezana D. Ivic

INTRODUCTION

Cytokinins have been shown to alter phloem unloading as well as sink initiation, strength and capacity. A broad mobilizing effect of cytokinins has been demonstrated using cytokinin applications to organs or tissues that caused an increased photosynthate transport to the site of cytokinin application. In sugarbeet, high endogenous cytokinin levels have been correlated with cambial initiation and rapid cell division in developing taproots, the sucrose storing organs of sugarbeet. Similarly, high cytokinin levels have been reported in synchronized taproot cell suspension cultures prior to cytokinesis. Based on these findings, it has been suggested that higher cytokinin levels might increase the cell division rate, vascular ring number, and sucrose accumulation in taproots.

To study the effects of cytokinin on various aspects of growth and sugar accumulation, sugarbeet cells were transformed with the isopentenyl transferase gene (*ipt*) (Snyder et al. 1999) that catalyzes the rate-limiting step of the cytokinin biosynthetic pathway. A number of morphological alterations commonly observed in *ipt* transformants were noted. Leaf and taproot cytokinin levels were elevated but leaf sucrose concentrations were comparable to those of the untransformed controls. Normal growth and development of the transgenic taproots was inhibited and resulted in decreased accumulation of sucrose.

MATERIALS AND METHODS

Transgenic sugarbeet plants, Pat-*ipt* 1 and Pat-*ipt* 2, carrying the gene for cytokinin synthesis (*ipt*) under the control of the patatin gene promoter (Pat) were generated by *Agrobacterium*-mediated transformation of cotyledons. For root induction, shoots (10 mm in height) were cultured on MSB medium (Snyder et al. 1999) with 30 g/l glucose and 5.0 g/l agar gel (Sigma, St. Louis, Mo) supplemented with indole-3-butyric acid (IBA) or with IBA and α-naphthaleneacetic acid (NAA) at 25 °C under continuous light. Shoots were exposed to 50 mg/l IBA for a 24 h period and then transferred to MSB medium without plant growth regulators or they were cultured on medium with 3 mg/l IBA and 2 mg/l NAA. Rooted plantlets were acclimatized in a growth chamber and transferred to a greenhouse.

Cytokinins were extracted in 80% methanol (10 ml/g of tissue) containing 20 mg/l butylated hydroxytoluene (BHT) at - 80 °C for 16 hours. Extracts were centrifuged (2000 x g, 10 min, 4 °C) and filtered through Whatman No. 1 filter paper. Pellets were briefly resuspended in same volume of 80% methanol and BHT, centrifuged and filtered as before. Combined filtrates were evaporated to an aqueous phase under vacuum at 35 °C and partitioned three times against n-pentane. Aqueous phase was applied to a Sep-Pack C_{18} column (Waters Corp., Milford, MA) prewashed with 2 ml methanol and 5 ml of H_2O. Cartridges were flushed with 5 ml H_2O and cytokinins eluted with 7 ml methanol. This fraction was dried under vacuum at 35 °C, redissolved in Tris-buffered saline and purified on columns packed with monoclonal anti-zeatin riboside (ZR) antibodies. The eluted cytokinins were quantified by ELISA using an analytical kit (Phytodetek-t-ZR, Idetek, Inc., San Bruno, CA). The anti-ZR antibodies provided in the

kit cross-reacted most strongly with trans-ZR, ZR-5'-monophosphate and trans-zeatin (Z). To determine percent recovery, control samples were spiked with 2000 pmol of trans-ZR. Analysis was done in triplicate for each of two 8-month-old greenhouse grown Pat-ipt 1, 2 and REL-1 plants.

Tissue samples were collected from 8- to 12-month-old fully expanded source leaves and taproots of the greenhouse grown plants. Two leaf discs (3.5 cm^2) and two taproot cores (0.1 to 0.3 g fresh wt) were taken from each plant between 4 and 5 h after the start of the photoperiod and were immediately frozen in liquid N_2 to stop metabolism. Samples were extracted with 2 to 4 ml methanol/chloroform/water (5:3:1) in a ground glass tissue homogenizer at 4 °C. Homogenates were centrifuged at 4000 x *g* for 5 min at 4 °C and the resultant pellets were re-extracted with 1 ml 80% methanol. The supernatant and wash fractions were combined and partitioned with 1 ml chloroform. Total chlorophyll (a + b) content in the organic phase was measured in 80% acetone. The alcohol fraction was evaporated to a minimum volume under a stream of N_2 at 37 °C and diluted to 1 ml with deionized H_2O. The soluble carbohydrates sucrose and glucose were determined in coupled enzyme assays. Taproots were placed in a forced-air oven at 80 °C for 72 h prior to dry matter determinations. Significant differences were estimated at the 5% level using a one-tailed Student's t-test assuming equal variances.

RESULTS AND DISCUSSION

Pat-*ipt* 1 and 2 shoots were propagated in tissue culture and transferred to auxin containing media for rooting. Pat-*ipt* 1 transformants rooted at a frequency of 65% after a 24 h exposure to 50 mg/l IBA in comparison to 86% of the untransformed control shoots. Roots were induced in 4 to 8 weeks on the *ipt* shoots and in 2 weeks on the

controls. Of the more than 100 Pat-*ipt* 2 shoots, only 4 shoots rooted on media containing both 2 mg/l NAA and 3 mg/l IBA. Attempts to root Pat-*ipt* 2 plants on lower or higher concentrations of auxin (25, 100, 150 or 200 mg/l IBA or NAA) with longer times of exposure (2, 4, 5 days; 2, 3, 4 weeks) were not successful. Unlike the untransformed controls, rooted Pat-*ipt* 1 and 2 plantlets had a very low survival rate when transferred to soil.

All greenhouse grown transgenic sugarbeet exhibited phenotypic alterations that have been previously reported for *ipt*-transformed plants. Pat-*ipt* 1 plants developed wrinkled leaves. Pat-*ipt* 2 plants had small, thick leaves and excessive axillary shoot development on a large, proliferative crown. Leaf chlorophyll levels were similar to those in untransformed plants. Pat-*ipt* 1 and 2 plants had smaller taproots averaging 18% and 1.2% of the untransformed control, respectively (Table 1). Leaf concentrations of the cytokinins zeatin (Z) and zeatinriboside (ZR) in Pat-*ipt* 1 and 2 increased 8- and 18-fold, respectively, as compared with the controls (Table 1). In the taproots, only a 2-fold increase was observed, but the control concentrations were about 4-fold higher than in the leaves. Therefore, the total Z and ZR content in transgenic leaves and taproots was not that different except for the Pat-*ipt* 1 leaves (Table 1). The observed phenotypes of the transformants correspond to those previously noted for *ipt* plants and are likely a primary or secondary response to the increased cytokinin levels and not tissue culture induced somaclonal variations since they were not noted in untransformed shoots that were propagated in the same fashion.

Leaf concentrations of sucrose in Pat-*ipt* 1 and 2 plants were not significantly different from those in control plants (Table 1). Glucose concentrations were highly

elevated in Pat-*ipt* 2 (68.3 ± 15.5 µmol/g fresh wt) but not Pat-*ipt* 1 leaves (Table 1). Sucrose hydrolysis during carbohydrate extraction did not appear to be a major source of the high glucose content since leaf fructose concentrations in Pat-*ipt* 2 plants were low (15.5 ± 1.5 µmol/g fresh wt; data not shown). Sucrose content in the taproots was significantly lower in Pat-*ipt* 1 and 2 plants than in the controls (Table 1), likely due to the reduced sizes of the roots. However, sucrose concentrations in 5 month-old taproots were elevated in comparison to the untransformed control. These results support the hypothesis that higher cytokinin levels may enhance sucrose accumulation in younger taproots but high sucrose levels may become detrimental to further development of a young taproot. More independent transformants and additional transgenic plants carrying the *ipt* gene construct fused to a promoter derived from sugarbeet taproot genes are needed for further studies.

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Table 1 Cytokinin and carbohydrate concentrations and taproot dry weights of sugarbeet transformants Pat-*ipt* 1 and 2 and untransformed REL-1 plants

Genotype	Z/ZR content [a] (pmol ZR equiv/g FW)	Sucrose [b] (μmol/g FW)	Glucose (μmol/g FW)	Dry Weight (g)
Leaves				
Pat-*ipt* 1	141 ± 25.1*	3.1 ± 0.3	4.1 ± 1.2	ND [c]
Pat-*ipt* 2	61 ± 10.2*	4.7 ± 2.2	68.3 ± 15.5*	ND
REL-1	8 ± 1.6	8.1 ± 3.2	5.6 ± 2.5	ND
Taproots				
Pat-*ipt* 1	65 ± 5.0*	147.2 ± 24.1*	1.00 ± 0.32	20.4 ± 7.1*
Pat-*ipt* 2	64 ± 11.3*	13.5 ± 9.5*	10.25 ± 9.7	1.3 ± 0.3*
REL-1	33 ± 3.6	389.5 ± 54.2	0.64 ± 0.3	111.3 ± 46.3

[a] Samples were taken from 8-month-old plants. Each value represents a mean of 2 experiments done in triplicate ± SE. Results are corrected for 100% recovery

[b] Values for carbohydrate concentrations are means ± SE of 8- to 12-month-old plants

[c] Not done

* Different from the control (REL-1), $p = 0.05$

Engineering sugarbeets with multiple proteinase inhibitor genes for enhanced tolerance to the sugarbeet root maggot

BSDF Project 811

Ann C. Smigocki and Stephen E. Wilhite

INTRODUCTION

The sugar beet root maggot (SBRM), *Tetanops myopaeformis*, was first described as a sugar beet pest in Utah in the 1920's. It is now considered the major sugar beet pest of the central and western sugar-beet-growing areas in the United States and Canada. Of the 1.5 million acres of sugar beet grown annually, nearly half are infested with the root maggot. The maggot inflicts significant crop damage and yield losses that can range from 10 to 100% in infested fields. An adult fly can lay as many as 200 eggs around the base of a sugar beet seedling during late May and June. As the eggs hatch, the developing maggots feed on tap and feeder roots throughout the growing season and either completely sever the roots of seedlings or badly scar the larger roots. Granular pesticides of the carbamate or organophosphate classes are often used to reduce larval populations in sugar beet fields. With the re-evaluation of pesticides mandated by the Food Quality Protection Act of 1996, the potential for loss of insecticides is real and alternatives few. Cultural control practices, such as crop rotation, have been ineffective mainly due to the mobility of the adult flies. Existence of several weed species as substitute hosts has also hindered population control. Thus, we need to explore alternative strategies for improved control of the maggot.

We are developing biotechnological approaches for introducing beneficial genes to target major sugar beet pathogens and pests, among them the root maggot. One of the searches for beneficial genes that specifically target the root maggot has led us to the maggot's digestive system. Insects posses digestive enzymes in their guts for release of essential nutrients from ingested foods. Normal growth and development of the maggots into adult flies depends on this process and, therefore, presents itself as an ideal target for insect control. By inhibiting the digestive enzymes in the maggot's stomach, the larva would in essence starve to death. Specific genes that produce potent inhibitors effective against digestive enzymes have been found to occur naturally in a number of plant species. It is speculated that in some cases these inhibitors may be part of the plant's natural defense arsenal for combating insect predators. Indeed, incorporation of some of the inhibitor genes isolated from one plant into another plant has been shown to be effective for insect control. However, it is necessary to determine the particular digestive enzymes of each individual pest species in order to devise a rational control strategy since significant variations have been found in the types and properties of digestive enzymes utilized by insects. In addition, plant inhibitors have been shown to posses varied specificity toward such enzymes. Latest studies on inhibition of insect protease activities by proteinase inhibitors indicate that a combination of inhibitors incorporated into insect diets is more toxic at levels where individual inhibitors are not toxic. Interestingly, higher levels of more than one proteinase inhibitor have been found in insect resistant vs. susceptible plants. Therefore, introduction of multiple proteinase inhibitor genes into transgenic plants will most likely prove to be the most effective and perhaps sustained means of controlling insect infestations.

MATERIALS AND METHODS

Sugarbeet root maggots (SBRMs) were collected as actively feeding 2nd instars from infested sugarbeet fields in Foxhome, MN. Midguts with full content were dissected under magnification within 48 h from time of collection. The body cavity was cut lengthwise and the midgut was excised excluding the fore and hind gut. Midguts were immediately placed in a micro-eppendorf tube embedded in dry ice. Samples consisting of 25-50 midguts were then frozen at -80 °C.

For extract preparation, frozen midguts were thawed on ice and homogenized following the addition of ice-cold citrate-phosphate buffer (pH 5.0) containing 0.1% Triton X-100. Debris was removed by centrifugation and supernatants were transferred to fresh tubes and pellets re-extracted. Pooled supernatants were clarified by an additional centrifugation and cleared supernatants were concentrated using Microcon-3 microconcentrators (Amicon, Inc.) and applied to a Bio-Gel P6 column (Bio-Rad). Flow-through was collected, aliquoted, and stored at -20 °C following determination of protein concentrations.

Enzyme extracts (containing from 5-15 μg protein) were combined with 5 μl of 2.4% Triton X-100, 34 μg of BSA, and 100 mM citrate-phosphate buffer at the appropriate pH to yield 40 μl. Eighty-microliters of 2% (w/v) azocasein (prepared in citrate-phosphate buffer of desired pH) was added, and the final reaction mix was incubated for 3 h at 37 °C. The final concentration of reactants was 0.1% Triton X-100, 0.028% (w/v) BSA, and 1.33% (w/v) azocasein in the 120 μl reaction mixture. Reactions

were terminated by adding 300 μl of 10% (w/v) trichloroacetic acid (TCA). Samples were incubated on ice for 10 min followed by sedimentation of un-digested substrate by centrifugation. The absorbance of the supernatants was measured at 335 nm.

Due to the insolubility of azocasein below pH 4.5, hemoglobin was used as the substrate for determination of pH optimum and for inhibitor assays carried out at pH 3.0. It was conducted in the same manner as the azocasein assay except the final concentration of reactants was 0.1% Triton X-100, 0.028% (w/v) BSA, and 0.67% (w/v) hemoglobin in the 120 μl reaction mix. Reactions were terminated by the addition of 300 μl TCA and the absorbance measured at 280 nm. We define one unit of enzyme activity as being the amount of enzyme that will produce an absorbance change of 1.0 h^{-1} in a 1 cm cuvette, under the conditions of the assay.

RESULTS AND DISCUSSION

The primary aim of this work was to identify the major mechanistic classes of digestive proteinases in SBRM midguts to aid in the selection of plant-derived inhibitors with potential use in generating transgenic plants to control SBRM. Proteolytic activity in extracts from SBRM larvae was measured from pH 2.5-10.0 with hemoglobin as substrate. Extracts consist of two distinct proteolytic components on the basis of pH optima. One component of activity is evident at acidic pH with an optimum of 2.5 or lower, whereas the other component has a pH optimum of approximately 9.5. These activities were examined at pH 3.0 and pH 8.5 by the addition of low-molecular weight biochemical inhibitors that target the three major mechanistic classes of insect digestive endoproteinases. Pepstatin A, E-64, and PMSF have preferential specificity toward aspartyl, cysteine and serine proteinases, respectively. Pepstatin A was by far the most

effective inhibitor at pH 3.0 (83.9% inhibition) corresponding to the acidic component of activity (Fig. 1A). Cysteine and serine proteinases have pH optimums of 4-7 and 7-9, respectively, suggesting that PMSF inhibition (12.5%) at acidic pH has little relevance, but does not rule out the involvement of cysteine proteinases. E-64, which has high potency toward virtually all known cysteine proteinases had only minor inhibitory activity (6.5%). At pH 8.5, corresponding to the basic proteolytic component, only the PMSF treatment resulted in a sizable decrease in proteolysis (47.3% inhibition). Pepstatin A and E-64 had little effect on proteolysis at pH 8.5, as would be expected since aspartyl and cysteine proteinases are not generally active at such high pH. Metalloproteinases, which generally are active at pH 7-9 and are inhibited by metal ion chelators such as EDTA also appear to be absent since 5 mM EDTA had no effect on proteolytic activity at pH 8.5. Thus, the only endoproteinases exhibiting considerable activity at basic pH are the serine proteinases, which are very common in Diptera.

The effect of several PIs on proteolytic activity was determined in order to confirm the identity of the classes assigned above. Squash aspartyl proteinase inhibitor (SQAPI) blocked virtually all the proteolytic activity at pH 3.0, thus confirming the importance of the aspartyl class at acidic pH (Fig. 1B). Soybean trypsin-chymotrypsin inhibitor (Bowman-Birk inhibitor I, or BBI) blocked nearly all proteolysis at pH 8.5, suggesting the presence of trypsin and/or chymotrypsin-like serine proteinases in the extract.

By analyzing the content of excised stomachs from feeding root maggots, we have identified two major classes of digestive enzymes as targets for control. For effective SBRM control, combining inhibitors for serine and aspartyl proteinases, such as

BBI and SQAPI, would be expected to yield better control than the use of either inhibitor alone. Next step will involve selection of effective inhibitors and reengineering of their respective genes for efficient production in the sugar beet root. To assist us with the genetic engineering of sugar beet, we have developed gene transfer methods that we are currently optimizing and testing on commercially important sugar beet breeding lines. In the near future, we plan to incorporate the inhibitor genes into sugar beet chromosomes for targeted, more environmentally compatible, control of the root maggot.

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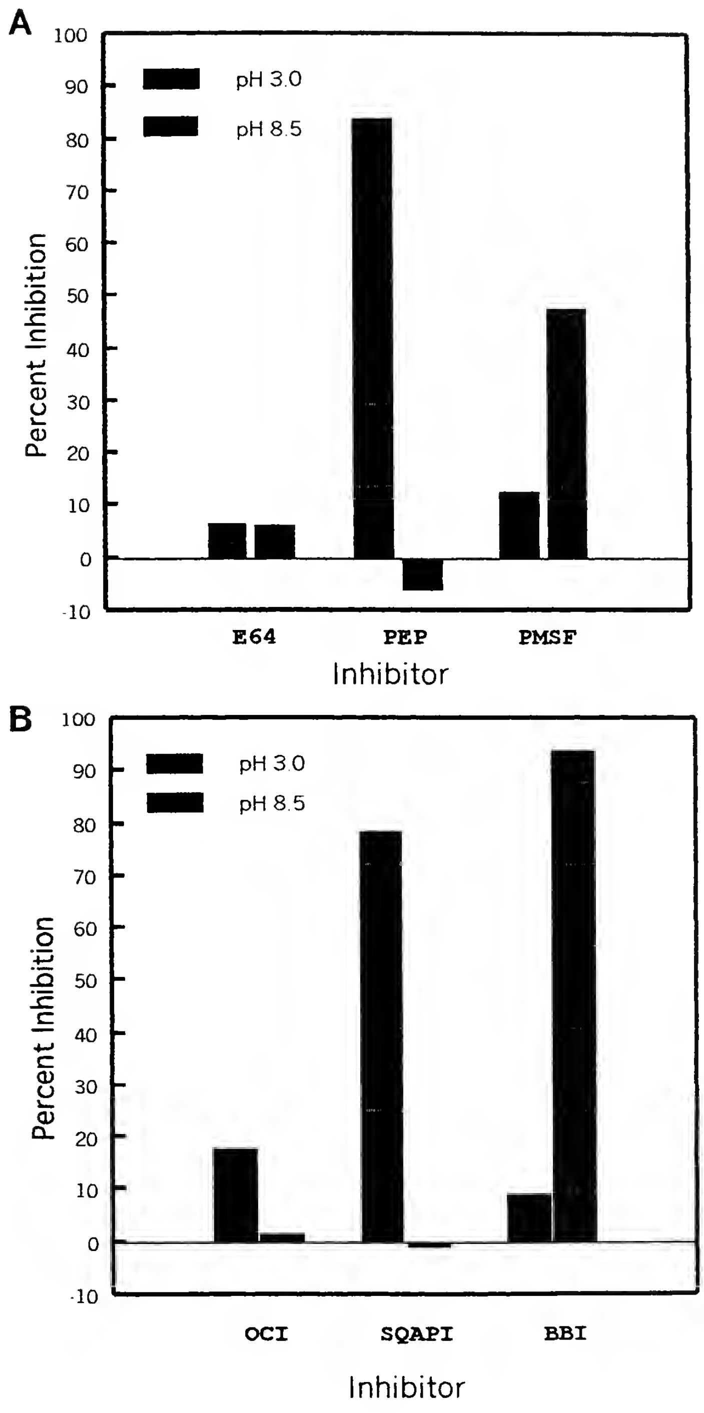

Fig. 1. Inhibition of general substrate hydrolysis by larval midgut homogenates at pH 3.0 and pH 8.5 with proteinase inhibitors. (A) Effect of low-molecular weight biochemical

inhibitors. E64, L-*trans*-Epoxysuccinyl-leucylamido(4-guanidino)butane; PEP, pepstatin A; PMSF, phenylmethylsulfonyl fluoride. (B) Effect of plant-derived PIs. BBI, Bowman-Birk inhibitor I (soybean trypsin-chymotrypsin inhibitor); OCI, oryzacystatin I GST-fusion; SQAPI, squash aspartyl proteinase inhibitor. Test levels were 50 μg for OCI and BBI, and 10 μg for SQAPI. All reactions consisted of 5-10 μg crude midgut protein.

Toward Improved *Cercospora* Leafspot Disease Resistance
Project Number 831

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Although the use of commercially produced chemical fungicides tends to select genetic mutants of *Cercospora beticola* with newly acquired fungicide resistance, they are still being used in an attempt to combat epidemics of foliar leafspot disease. New fungicide-tolerant mutant strains of *Cercospora* diminish the effectiveness of chemical spraying to control foliar leafspot. Infected sugarbeet plants survive microbial infection but tonnage and sucrose percentage are both significantly diminished, as foliar regrowth after infection depletes the plant's energy reserves. The construction of transgenic plants with chimeric genes responsible for producing safe new biofungicides and other "natural" antimicrobials potentially offers an effective and economical means of controlling crop losses due to fungal disease without either the expense of fungicides or potential deleterious environmental consequences of their use. "Chimeric" genes are those genes from various origins that have been fused *in vitro* with appropriate plant gene "promoters" to optimize their expression in the target plant species. The bioengineering of new disease-resistant, high-yielding sugarbeet germplasm could potentially bring about an overall 30% increase in crop profitability.

Besides *Cercospora*, other fungal diseases of significance to the sugarbeet industry include *Rhizoctonia* and *Aphanomyces,* both causes f root rot. Additionally, pre-emergent sugarbeet seedlings in production fields often succumb to seedling root rot caused by either or both of these. *Aphanomyces* is only one disease-causing micro-organism infecting sugarbeets, but several labs have recently considered it to be a useful model system for disease management. Since soilborne diseases like *Aphanomyces* and *Rhizoctonia* cannot realistically be managed using fungicides, the construction of new, bioengineered transgenic plants producing their own biofungicides could provide effective resistance to infections caused by *Aphanomyces, Rhizoctonia* and other fungal pathogens.

New biofungicides are being discovered annually. Before he retired, Dr. Garry Smith supplied Dr. Kuykendall with some potential biocontrol bacteria that he and John Eide had isolated from the rhizospheres of healthy sugarbeets grown in North Dakota. Their antagonism against *Cercospora* has been confirmed in Kuykendall's Beltsville lab. Two strains of *Pseudomonas,* one that is closely related to *P. corrugata* and another more similar to *P. tolassi* have been microbiologically analyzed. We plan to transfer the *Pseudomonas* genes responsible for the production of biologically produced fungicides to sugarbeet in order to control both foliar leafspot and root diseases. Dr. Hu, from Wuhan, China, has been visiting our lab to help clone and subclone relevant *Pseudomonas* genes for this purpose. More research is needed to determine the usefulness of the DNA segments we are currently sequencing. Another experiment in progress involves the transfer of *cfp*, the gene from *Cercospora* responsible for the export of cercosporin toxin,

via *Rhizobium* (formerly *Agrobacterium*) into sugarbeet, as this gene could potentially confer a high degree of *Cercospora* immunity in this species. Currently my lab is repeating a *cfp* transformation that was evidently successful in the first two attempts. Disease resistance confirmation remains to be seen in these plants.

Snyder, Ingersol, Smigocki & Owens (1999) reported the development of transgenic sugarbeets carrying genes encoding pathogen-defense related proteins under transcriptional control of stress- or wound-inducible promoters. These novel plant genotypes have been recently examined for their ability to make antimicrobial compounds (Kuykendall and Smigoki, 1999). Two promising transgenic sugar beet genotypes, OOT ans *osm*PR-S, with antimicrobials under the control of the strong osmotin promoter, were increased by vegetative propagation, and the results of their examination for *Cercospora* leafspot resistance is part of this report.

Last year the two new transgenic genotypes named above were reported to evidently have some *in vitro* anti-*Cercospora* activity. These genotypes were vegetatively propagated and then a number of plants of each clone were evaluated for *Cercospora* leafspot disease susceptibility under high humidity in an environmentally controlled plant growth chamber. The experimental results, presented in Vancouver, B.C., in early March, 2001, showed clearly that these particular transgenic sugarbeet genotypes had less *Cercospora* resistance that their parental genotype, surprisingly. As part of this experiment a successful *Cercospora* leafspot test was developed.

Sugarbeet transformation and regeneration research has recently been more successful at Beltsville largely due to Dr. Joseph Saunders' visits to our labs last summer and fall when he transferred the technology for efficient sugarbeet regeneration that he had developed in East Lansing at the Michigan State University/ARS Bean and Sugarbeet Research Unit. Also, Joe's paper for the Vancouver meeting points the way to an improved transformation and regeneration protocol which takes only a few months. Direct selection of cercosporin resistant mutants was also evidently successful but more work is needed to confirm this unexpected finding, again largely due to Joe's efforts.

Simple and efficient genetic transformation in sugarbeet has long been unavailable because of the absence of a satisfactory technology for the direct (i.e., not involving callus) *de novo* formation of shoots from leaves or parts thereof. However, of course, such a system has long been available for use with *Rhizobium* (formerly *Agrobacterium*) for the transformation of tobacco, for example. Labs have reported the formation of adventitious shoots from *in vitro* grown sugarbeet shoots and seedlings, or from leaf pieces and thin cell layers from these, but these adventitious shoots were thought to come from pre-formed meristematic 'initials' induced during the prior *in vitro* culture of the donor shoots and seedlings. Thus they were not considered amenable for either direct selection or genetic transformation. This year, we obtained direct adventitious shoots in a one step procedure using leaf pieces of greenhouse-grown plants sugarbeet clone REL-1. Most leaf pieces regenerated one or more shoots with single midvein pieces one-to-two cm long initially placed on semi-solid Murashige-Skoog media with 1 mg/L N^6-benzyladenine and maintained at about 23.5^0 C for seven-to-twelve weeks in low light

intensity light from overhead fluorescent lamps. This new finding, i.e., regeneration without callus or high temperature, seems likely to provide for the simple and efficient regeneration that has long been needed for genetic transformation of sugarbeet.

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Characterization of a Fungal Pathogen of the Sugarbeet Root Maggot
BSDF Project 850
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Biological control agents are increasingly becoming part of integrated pest management programs for plant pest and disease problems. Increasing scrutiny of some chemical control methods with anticipated reductions in use or the potential for loss of labeling for specific uses has heightened the search for practical alternatives. To this end, at least three laboratories are working toward development and testing of biological agents targeting the sugarbeet root maggot, *Tetanops myopaeformis*.

An analysis of field collected sugarbeet root maggot (SBRM) larvae led to discovery of a fungal pathogen with properties consistent for development of a biopesticide. Surveys of microbes associated with the SBRM in 1994 in the Red River Valley (RRV) of Minnesota and North Dakota led to the discovery of *Syngliocladium tetanopsis*, a new fungal species. Specimens were isolated from larval SBRM cadavers from several locations around the RRV and although some striking cultural differences were noted, all were of similar morphology and identified as conspecific.

Based on the novel nature of this species and its evidence as the first natural pathogen of the SBRM, a patent was issued through the U.S. patent Office in 1999. In conjunction with this process, three of the principal strains examined were deposited in the USDA's Northern Regional Research Laboratory (NRRL) in Peoria, IL (NRRL 21853, 21854, 30031). Identical cultures were also placed into the ARS entomopathogenic fungal (ARSEF) culture collection at Ithaca, NY. Two commercial interests have filed Material Transfer Agreements with ARS to evaluate this fungus for production of an economically feasible control agent. Dr. Stefan Jaronski of the ARS lab in Sidney, MT is also working with this fungus to assess its potential as a biocontrol agent. Of the 37 isolates cultured from field collected SBRM larvae, the majority have been transferred to collaborators.

In vitro assays have determined that all isolates are infective toward SBRM third instar larvae. A few of these isolates have also been tested on first instar larvae and found to be highly virulent. In fact sporulation commenced on first instar cadavers within 6 days of inoculation with conidiospores in some experiments. Mortality has reached 96 % (n=120) with some isolates in bioassays of third instar SBRM and 100 % with first instars (n = 40). Although not experimentally evaluated, adult infections have been observed under laboratory conditions.

Current objectives for research on this agent include the refinement of culture conditions to enhance the rate and quantity of spore production, assess the viability of spore preparations through fluorescent cellular probes, and to determine the host range of *S. tetanopsis*.

Culturing of the fungus has been on a modified oatmeal medium (OatM) wherein olive oil and cholesterol have been added to increase the lipid content. With most isolates spore yield is high on this medium, however, time to sporulation varies from as little as 14 days to over 6 weeks. Amendments containing organic nitrogen, such as casein hydrolysate, yeast extract, dried milk, tryptone, or peptone, were added to OatM to enhance growth rate. All sources of nitrogen resulted in a more rapid rate of early hyphal growth, however, sporulation was significantly delayed as compared to OatM.

Liquid shake cultures of *S. tetanopsis* that were initiated in soy and beef protein digests are currently being examined as a means of rapid mycelial production for use as inoculum of a second solid substrate (*e.g.*, grain).

Work with cryopreserved spore and mycelial preparations determined that viability could be maintained for at least 60 months at -80°C. More relevant, however, is the stability of preparations as would be typical of biopesticidal products (*i.e.*, shelf-life at room temperature or under refrigeration). Cultures dried under ambient conditions have yielded viable spores after 12 months, although quantitation was not possible at the time of assay. Somewhat surprisingly, spore preparations maintained in 0.85 % saline for 5 months at room temperature yielded viable colonies when plated onto OatM. These findings suggest that spore stability over time may not be a limiting factor in development of a commercial formulation. These experiments will be repeated once the details of the fluorescence viability assays are completed.

Both *Drosophila melanogaster*, the common fruit fly, and *Musca domestica*, the house fly, were examined for susceptibility to this fungus. Bioassay data indicate that these species are not detrimentally affected by treatment with conidia of *S. tetanopsis*. Fruit and House fly challenges were performed on first and second instar larvae (15 to 25 / dish) by directly inoculating larvae with conidiospore suspensions (3 x 10^5 / mL) and wetting of food (chopped liver - house fly; banana - fruit fly) and substrate surfaces (filter paper) to ensure > 3 x 10^5 spores / dish. Larvae were incubated at 27 °C and observed until pupation. Mortality in control (saline) and fungal treatments were very low in both instances with no evidence of infective pathology on either insect. Larvae were held through pupation into the adult stage for observation.

While it is somewhat disappointing that the apparent host range of this pathogen is very narrow, this can be seen as a positive result from a regulatory standpoint. Impacts on non-target insects and other invertebrates are part of the standard risk assessment performed prior to registration of microbial biopesticides in the U.S. and Canada. Organisms (pathogens, parasites) with defined host ranges generally require fewer studies for environmental assessment and approval.

The ability of *S. tetanopsis* to infect SBRM larvae (and adults to a lesser extent), persist in the soils of the Red River Valley (ND / MN), and be easily cultured, suggest that this pathogen has potential as a biological control agent for management of this destructive insect. The proper delivery system could provide for an effective alternative to current granular insecticides or as an amendment to these treatments under suitable field conditions. The parameters that influence this fungus in the soil and its efficacy as a biopesticide are only poorly understood presently. Further research will include an assessment of SBRM larval mortality and sugarbeet yield (tonnage, % sucrose, root damage ratings). Most likely this agent would be applied as a granular in-furrow at planting or as a seed coating treatment. Collaborative efforts have been established with ARS and University researchers to evaluate this agent under field conditions of high maggot infestations.

SUGAR BEET RESEARCH

2000 REPORT

Section G

University of Illinois
Urbana, Illinois

Dr. D. R. Bush

This research was supported in part by funds provided through the Beet Sugar Development Foundation (Project 840)

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BEET SUGAR DEVELOPMENT FOUNDATION
Research Report 2000

New Strategies for Modifying Sucrose Distribution in Sugarbeet

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The primary aim of this project this year was to investigate further our recent discovery of a control pathway that regulates sucrose loading into the vascular system in the leaf (Chiou and Bush 1998). The vascular system mediates the long distance transport of sucrose from the photosynthetic cells in the leaf to the sucrose storage cells in the tap root. This was a very significant finding because loading the vascular system for sugar export from the leaf is the key step that determines how much sucrose is delivered to the tap root. Defining the biochemical steps involved in controlling sucrose distribution to the beet will allow us to develop new strategies for manipulating productivity (Bush 1999). The second goal was to test the hypothesis that directed expression of a hyperactive sucrose transporter can modify sucrose accumulation in the beet. Unfortunately, our attempts to transform sugar beet this year stalled because we were not able to identify a lab with a high efficiency transformation system to collaborate with. As I noted in this year's proposal, I consider this to be a major limitation to improving sugar beet using biotechnology.

Recent Progress

The objective of our investigation of the regulatory system that controls sugar export from the leaf was to identify the biochemical steps involved in modifying the sucrose transporters ability to load the vascular tissue of the plant. Our initial analysis of this system showed that it controls sugar allocation between photosynthetic tissues and "import-dependent" organs like the beet tap root (Chiou and Bush 1998). Using Western blot analysis, we recently showed that down regulation of sugar transport activity is the result of protein degradation where the transporter is removed from cells that load the leaf vascular system. In parallel with its turnover, we used nuclear run-offs to show that decrease transporter-mRNA abundance is the result of down-regulation of gene expression. Additional experiments showed that both transporter protein and mRNA turnover very quickly (T1/2 = 2 hr). This is a hallmark characteristic of a tightly regulated biological process. Thus, it appears that dynamic regulation of sucrose transporter abundance in the vascular system controls sugar allocation.

We then went on to show that protein phosphorylation pays a key role in the signal transduction pathway that controls the expression of the sucrose transporter. This then controls sucrose allocation to the tap root by altering the capacity of the leaf vascular system to load sucrose and transport it to the root. This was another major finding and one that is driving new experiments aimed at identifying the sucrose sensor.

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